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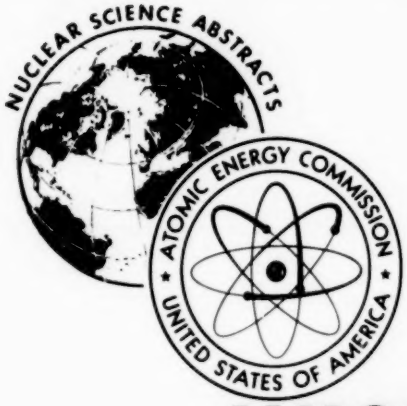

APR 10

NUCLEAR SCIENCE ABSTRACTS

Volume 19 Number 14

Abstracts 25820 – 27895

July 31, 1965

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Volume 19, Number 14, July 31, 1965

NUCLEAR SCIENCE ABSTRACTS

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Volume 19, Number 14 July 31, 1965

NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

Refer also to abstracts 26380 and 26917.

25820 (AD-608798) HUMAN ENGINEERING OR ENGINEERING OF THE HUMAN—WHICH? Robert S. Pogrund (Space Technology Labs., Inc., Los Angeles, Calif.). [1960]. 41p. $2.00(CFSTI).

The degree of compromise between the human engineer and the physiologist is a function of space flight duration. Short trips will permit the designing of the space capsule and its internal environment with a minimal degree of comfort to the human passenger. Medium length trips of interplanetary magnitude will require a duplicate of man's comfortable terrestrial environment, if he is to operate optimally as a scientific observer, capable of high performance levels. Extended interstellar space travel may not require the presence of incessant human intelligence, so that aids for ultimate survival are drawn from considerations of pharmacologic agents, hypothermia, adaptation, and Yoga. (69 references.) (auth)

25821 (COO-38-369) GENETICS AND THE PHILOSOPHY OF BIOLOGY. A. E. Manier and H. A. Bender (Notre Dame Univ., Ind.). Oct. 1, 1964. Contract AT(11-1)-38. 38p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Current views concerning applications of logic and semantics to biological problems are reviewed. Concepts that are regarded as distinctive of the life sciences, such as teleology or directive organization, wholeness or the existential dependence of part on part, and complexity or variability of individual form are examined as to their relation to the life sciences. It is postulated that solutions of the various problems raised by investigations in the philosophy of biology can best be approached through methodological investigations in certain areas of biology such as theoretical genetics. The history of genetics is reviewed briefly, various hypotheses are reviewed, and the chromosome theory of heredity is discussed at length. (100 references.) (C.H.)

25822 (LA-DC-6794) AUTOMATIC DATA ACQUISITION, REDUCTION AND ANALYSIS. P. N. Dean and C. R. Richmond (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1964]. Contract [W-7405-eng-36]. 42p. (CONF-650507-3; SM-61/34). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Applications of automatic data acquisition, reduction, and computer analysis to radiobiological studies are discussed. It is pointed out that the usefulness of computers is limited unless the means of getting data to them is fast and reliable. The complete automation of 4 different γ assay devices is described, and the relative merits of various methods of transferring data from counters to computer-compatible forms are discussed. Applications of computer methods in metabolic studies are described. (C.H.)

25823 (ORINS-49) OAK RIDGE INSTITUTE OF NUCLEAR STUDIES MEDICAL DIVISION RESEARCH REPORT FOR THE YEAR ENDING DECEMBER 31, 1964. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.). Contract [AT(40-1)-Gen-33]. 140p. Dep.; Free(ORINS Medical Div.).

Separate abstracts were prepared for nine sections of this report. A list is included of publications during the period. (C.H.)

For abstracts of individual sections see: 25840, 25906, 25907, 26109, 26160, 26161, 26162, 26232, and 26667.

25824 (ORNL-P-67) MITOCHONDRIAL DIVISION IN PHYTOHAEMAGGLUTININ-STIMULATED HUMAN LYMPHOCYTES. Hiroshi Yamamoto (Oak Ridge National Lab., Tenn.). [1963]. Contract [W-7405-eng-26]. 16p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The structure of mitochondria is reviewed. Results are reported from studies of morphological alterations during mitochondrial division in phytohaemagglutinin-stimulated human lymphocytes in culture. The relation of these alterations to the mechanism by which new mitochondria are formed is discussed. (C.H.)

25825 (TID-3512(Suppl. 1)) ISOTOPE TECHNIQUES IN THE BIOLOGICAL SCIENCES. A Literature Search. Helen L. Ward, comp. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). May 1965. 45p. Dep.; $2.00(cy), 1(mn) CFSTI.

A total of 463 selected references to literature published from 1958 through 1963 on techniques and instruments for using radioisotopes in biological studies is presented. Author, isotope, and report number and availability indexes are included. (C.H.)

25826 THE CALCULATION OF RADIATION DOSE FROM DISTRIBUTED SOURCES OF TRITIUM. F. S. Stewart (Mount Vernon Hospital, Northwood, Middx., Eng.). Intern. J. Radiation Biol., 8: 545-9(1964).

Formulae derived by Rossi and Ellis (1950) for the calculation of radiation dose from distributed sources of beta-emitters have been made applicable to the case of tritium by a consideration of the appropriate value for the effective absorption coefficient employed in these expressions. An example is given of their application to the calculation of dose to a cell from tritium incorporated in the nucleus. (auth)

25827 IN VITRO ASSESSMENT OF CELL VIABILITY IN HUMAN BONE MARROW PRESERVED AT −79°C. D. E. Pegg (Westminster Hospital, London). J. Appl. Physiol., 19: 123-6(Jan. 1964).

The reliability of four selected viability tests in measuring the survival of human bone marrow after storage at

−79°C with glycerol or dimethyl sulfoxide was assessed. Bone marrow was stored by a variety of techniques including some which are known to be inefficient, and the results assessed by these criteria. Samples were sealed in an aluminium/polyethylene sachet. One sample containing each diluent was stored for 1 hr at room temperature, one was plunged into a bath of ethanol at −70°C (cooling rate = 120°C/min), and one was cooled slowly. After 1 hr at −70°C, the frozen samples were thawed in a water bath at +40°C (thawing time = 30 sec) and each sample was tested for nuclear staining with trypan blue, DNA synthesis using tritiated thymidine followed by autoradiography, motility by phase-contrast microscopy, and cytoplasmic red fluorescence with acridine orange. The results showed that, by comparison with the established effects of these preservation procedures on the radiation recovery factor: (1) the dye exclusion test using trypan blue is a poor indicator of viability after freezing; (2) measurement of DNA synthesis gives results which correlate well with in vivo assays; (3) detection of motility is the only in vitro test to provide unequivocal evidence of life, but is not susceptible to quantitative measurement: slow cooling in the presence of glycerol or dimethyl sulfoxide was the most successful preservation procedure used; (4) supravital staining with acridine orange, although it is a purely empirical test, gives a good correlation with the results of in vivo assay and is simple, convenient, and rapid to perform. Exposure to glycerol produced more damage than exposure to the same concentration of dimethyl sulfoxide. (BBB)

25828 DEVELOPMENTAL EFFECTS OF RARE EARTH IONS ON THE CHICK EMBRYO. Hani Khalil Battikh. Thesis, Charlottesville, Va., Univ. of Virginia, 1964. 77p.

Chlorides of yttrium, cerium, praseodymium, neodymium, gadolinium, dysprosium, erbium, and ytterbium were dissolved in chick Ringer's solution and injected into the yolk of unincubated eggs in dosages of 5-10 mg/egg. The percent of mortality with 10 mg/egg was 45.4 for praseodymium, 36.2 for erbium, 31.5 for ytterbium, and 16.5 for gadolinium. Controls injected with saline showed a mortality of about 16%. Praseodymium, gadolinium, erbium, and ytterbium inhibited development of the brain and increased the frequency of omphalocephalic embryos. In three cases, praseodymium, gadolinium, and ytterbium caused a shift of embryonic axis to the extreme anterior end of the area pellucida. The developing embryo was a miniature, which lagged 5 stages behind the control, but was well-proportioned and normally oriented. Yttrium caused a reduction in the number of primary erythrocytes and in the amount of hemoglobin. Treated embryos lagged almost 2 stages behind the controls. Cerium produced large vesicles in the entoderm of the area vitellina, which were triangular in cross section and bounded by the membranes of adjoining entodermal cells. Dysprosium inhibited the development of the left side of the brain, but not the right side, which proceeded to form small, multiple neural canals. Neodymium stimulated erythropoiesis, increasing the number of the primary erythrocytes and the amount of hemoglobin synthesized. Studies with cerium-141 showed that the entodermal cells took up the chemical whenever it was in their vicinity. The ions reacted with the yolk, especially the "white type," forming a complex. The activity was concentrated later within the nuclei of the entodermal cells. In the embryo, the activity was found exclusively in the nuclei of the erythrocytes. (A.G.W.)

25829 THE KINETICS OF TUMOR CELL PROLIFERATION. Mortimer L. Mendelsohn (Univ. of Pennsylvania, Philadelphia). p.498-513 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Two questions are posed concerning the cell cycle in tumors: given an experimental tumor and the techniques of kinetic analysis can the parameters of the cell cycle be determined for tumor cells, and can these methods be extended to a single tumor—such as a particular clinical neoplasm—or to categories of clinical tumors. The answer to the first appears to be that information about the cell cycle can be obtained from experimental tumors using a variety of laboratory techniques. With the possible exception of the growth fraction method, the approaches used require multiple samples of tumor over extended periods of time. These are complex procedures and are ill-suited for clinical application. Thus a partial answer to the second question is that these particular techniques have little or no applicability to the evaluation of the individual clinical neoplasm. Unfortunately, once one has accepted the concept of nonproliferating tumor cells, one is committed to the proposition that cell-cycle time cannot be estimated from growth curves, mitotic index determinations, or techniques such as colchicine blockade and accumulation of mitotic figures as a function of time. (H.G.D.)

25830 HIGH-INTENSITY ELECTRONS FOR RESEARCH AND THERAPY. John S. Laughlin (Memorial Hospital for Cancer and Allied Diseases, New York and Sloan-Kettering Inst. for Cancer Research, New York). p.599-602 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Implications of electron irradiation carried out at ultra-high dose rates for radiobiological research and therapy are discussed. Physical advantages existing in the present use of electrons are: definite range, adjustable depth, minimal interface discontinuities, and absence of increased absorption in bone. It is concluded that the study of mechanisms of both biological and chemical effects of radiation would be aided by the use of doses delivered in pulses of duration comparable to the lifetimes of the radiation produced free radicals. Moreover, such high intensity electrons have promising therapeutic applications. (H.G.D.)

Ecology

Refer also to abstract 26534.

25831 (NYO-3273-6) RADIOCHEMICAL AND RADIOECOLOGICAL STUDIES ON BRAZILIAN AREAS OF HIGH NATURAL RADIATION. E. Penna Franca (Brazil Univ., Rio de Janeiro. Instituto de Biofisica). Apr. 30, 1965. Contract AT(30-1)-3273. 97p. Dep.(mn); $4.00 (cy), 3(mn) CFSTI.

Progress is reported in radioecological studies in three areas of high natural radioactivity in Brazil. The regions include the Guarapary area in the monazite sand region, the Araxá area and the Morro do Ferro (Iron Hill) in the volcanic intrusive region. The three sites are quite different in character. Lithium fluoride thermoluminescent dosimeters were enclosed in religious medals and distributed to men and women in different age brackets to be worn for 3 months. Of 122 medals recovered, only 4 dosimeters were damaged. Comparison of results obtained with these dosimeters and other measurements indicated the dosimeters gave consistent results. Preliminary results are included from measurements of the radioactivity in different types of houses, determinations of the content of ^{226}Ra in teeth and water supplies, and measurements of total radioactivity in samples of food, sand, soil, urine, and feces collected in the regions. Cumulative lists of plants and animals collected in the Morro do Ferro area are included. Data are included from studies on the ecology of Drosophila willistoni and scorpions, Tityus bahiensis, collected in the areas. (C.H.)

25832 (TID-21827) BIOCLIMATIC AND SOILS INVESTIGATIONS IN FOREST ENVIRONMENTS. VI. GROSS PRECIPITATION AND THROUGHFALL STUDIES AT NEOTOMA. Victor L. Riemenschneider (Ohio State Univ., Columbus. Dept. of Botany and Plant Pathology and Ohio Agricultural Experiment Station, Wooster). Aug. 1964. Contract AT(11-1)-552. 73p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Neotoma, a small wooded valley located 8 mi southeast of Lancaster, Ohio, has been the site of ecological and bioclimatic studies since 1922. Data on precipitation and throughfall at 3 bioclimatic stations within a mixed meso-

phytic plant community during 1963 are compared with data collected since 1954. (C.H.)

25833 CONCENTRATION OF COMMON CAESIUM IN ANIMAL AND HUMAN MUSCLES. I. V. Burovina, D. G. Fleishman, V. P. Nesterov, M. N. Shmitko, and I. A. Skulskii (Sechenov Inst. of Evolutionary Physiology and Biochemistry, Leningrad). Nature, 205: 1116-17(Mar. 13, 1965).

It is necessary to know the natural content of stable Cs in various organisms in order to predict the equilibrium distribution of ^{137}Cs in the biosphere. The Cs content in muscle of fish, birds of passage, cows, reindeer, and man was measured by the isotopic dilution method using a mass spectrometer. Potassium was measured with a flame photometer. The K content of the samples differed only slightly, whereas the content of ^{133}Cs or the ratio of ^{133}Cs/K in the same samples varied greatly from one species to another. The content of ^{133}Cs in organisms was found to be related to the ratio of $^{133}Cs/K$ in the diet and to the mineral metabolism, and a correlation was found between the content of ^{133}Cs and ^{137}Cs in the muscles of different organisms. It is concluded that data on ^{133}Cs and information about the nature of radioactive fallout in different areas of the world can be used to predict both the possible migration of ^{137}Cs in the food chain and the picture of the equilibrium distribution of ^{137}Cs in the biosphere. (C.H.)

25834 A STUDY OF STRONTIUM, BARIUM, AND CALCIUM RELATIONSHIPS IN SOILS AND VEGETATION. John Francis Gamble. Thesis, New Brunswick, N. J., Rutgers Univ., 1964. 116p.

Sr, Ba, and Ca relationships in soils and vegetation were studied at three locations in New Jersey. A spectrochemical procedure was developed for direct powder analysis of soils using a d-c arc excitation in an $A-O_2$ atmosphere. Foliar analysis was by the $NaNO_3$ buffer method and certain trace elements were determined by a concentration procedure. Foliar samples were taken from representative species of the overstory, understory, and ground cover at each location. Element variation in the leaf tissue was measured as a function of species, location on the plant, size of plant, and sampling error. At one location (Sassafras soil), the vegetation was analyzed in successive years. Sampling variation due to location on the plant was not noted. Major elements K, Ca, Mg, Mn, Al, Cu, Ba, and Sr showed little variation between years. Trace elements, Mo, Cd, Co, Pb, Zn, Ga, Si, V, and Ni showed large variations within species and between years. Ti content was used as an index of surface contamination. Element comparisons of the foliar analyses showed a high degree of species specificity. There were few apparent relationships between the soils and foliar analysis and none between Sr, Ba, and Ca. Sr, Ba, and Ca did not appear to have any specific relationship except within species. Concentration averages in the total soil (<0.044 mm) analysis were:

	Sr ppm	Ba ppm	Ca ppm
Montalto	82	470	4800
Sassafras	72	515	1800
Lakewood	70	260	1000

Distribution of Sr, Ba, and Ca in the soils studied is only slightly influenced by pedogenic factors. No strong geochemical distribution relationship was noted between Sr, Ba, and Ca. The Ca: Ba ratio and Ba: Sr ratio were more closely related among the three soils than the Ca: Sr ratio. (Dissertation Abstr., 25: No. 5, Nov. 1964)

Metabolism, Tissue Distribution, and Toxicology

Refer also to abstracts 26251, 26256, 26413, 26579, and 26603.

25835 (BNL-8730) STUDIES ON SERUM BINDING OF VITAMIN B_{12}—MECHANISMS AND CLINICAL IMPLICATIONS. Leo M. Meyer (Long Island Jewish Hospital, Jamaica, N. Y. Queens Hospital Center Affiliation and Brookhaven National Lab., Upton, N. Y.). Dec. 29, 1964. Contract AT-30-2-GEN-16. 46p. (CONF-703-3). Dep. (mn); $2.00(cy), 1(mn) CFSTI.

From 10th Congress of the International Society of Blood Transfusion, Stockholm, Sept. 1964.

Results are reported from a series of studies on the vitamin B_{12} binding capacity of serum in health and disease in which ^{57}Co, ^{58}Co, or ^{60}Co were used as a tracer. Data are included on the distribution of labeled cyanocobalamin in human tissues and organs. Results indicate that the origin and nature of B_{12} binding proteins is not established and that endogenously bound B_{12} protein in serum is probably an unsaturated seromucoid which migrates with alpha 1 and alpha 2 globulins on electrophoresis. Addition of cyanocobalamin saturates this protein and the vitamin then becomes attached essentially to β globulin. (63 references.) (C.H.)

25836 (EUR-487.f(Vol.I)) ABSORPTION ET LOCALISATION DU STRONTIUM ET DU CALCIUM DANS LES VEGETAUX. (Absorption and Localization of Strontium and Calcium in Plants). C. Myttenaere, R. Kirchmann, X. Dalschaert, M. Debot, and E. Fagniart (Centre d'Étude de l'Énergie Nucléaire, Mol (Belgium)). 1965. 20p. Dep. (mn).

The effect of the Sr/Ca ratio in the nutrient solution was studied in Pisum sativum. The ratio was varied while the sum of the two ions was maintained constant at 5 meq/l. The amount of stable Sr in the seed was determined by radioactivation (0.5 μg/seed). More than half of this amount was localized in the spermoderm. Such a result was also found for calcium. The substitution of Ca by Sr reduces the growth of Pisum; however, a partial substitution ($^1/_{100}$ of the total $Ca^{++} + Sr^{++}$) was beneficial. The observed ratio is not a constant and varied with the organ and the Sr/Ca ratio of the nutrient medium. At very low Sr/Ca ratios, as in soil, taking into account the low Sr concentration and its high retention, the amount of Sr in the shoot is lower than in the roots. Higher Sr/Ca ratios give opposite results. A low Sr/Ca ratio results also in a different chemical distribution (%) of the absorbed Sr and Ca. The discrimination made by animals between Sr and Ca could be partly attributed to the quality of the ingested plant material. (auth)

25837 (EUR-487.f(Vol.II)) ABSORPTION ET LOCALISATION DU STRONTIUM ET DU CALCIUM DANS LES VEGETAUX. (Absorption and Localization of Strontium and Calcium in Plants). C. Myttenaere, R. Kirchmann, X. Dalschaert, M. Debot, and E. Fagniart (Centre d'Etude de l'Énergie Nucléaire, Mol (Belgium)). 1965. 37p. Dep.(mn).

In aquaculture, the substitution of Ca by Sr reduces growth of plants. This effect is more evident in Pisum sativum than in Zea Mays. However, in sandculture, the Sr/Ca ratio of the nutrient medium does not influence the distribution of Sr: the roots have always the highest content; the seed the lowest. In Pisum, the spermoderm/cotyledons ratio (^{85}Sr) increases with the Sr/Ca ratio of the nutrient medium. The same result was obtained for the shuck/cob ratio in Zea Mays. In both species, the shoot is always higher in Ca than the roots. In Pisum grown in waterculture, the physiological distribution of Sr and Ca is a function of the Sr/Ca ratio in the nutrient medium. The lower Sr/Ca ratio is, the higher is the quantity of Sr fixed in the walls. The proportions of Ca and Sr found in the cell walls and in the cell sap are equal where the ratio in the nutrient solution is equal to one. In the walls Sr is not all chemically fixed (pectate i.e.) but a certain fraction is exchangeable. As previously reported for Ca, these results would confirm the theory of the translocation of Sr by exchange. The discrimination made by animals between Ca and Sr could be partly due to the ingested plant material (passive discrimination) as well as to the animal (active discrimination). (auth)

25838 (NP-14903) INCORPORACION DE PRODUCTOS DE FISION EN PLANTAS ACUATICAS. Informe No. 138.

(Uptake of Fission Products by Aquatic Plants. Report No. 138). Dan Beninson, Eric Vander Elst, and David Cancio (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1964. 14p. Dep.(mn).

A laboratory study was made of the uptake of ^{90}Sr, ^{137}Cs, rare earths, ^{106}Ru, and ^{95}Zr by the aquatic plants of the small rivers of Ezeiza, Province of Buenos Aires. The experimental techniques are described. The factors of discrimination or concentration were determined for each of the elements and the results were discussed. (J.S.R.)

25839 (NYO-1918-100) BIOLOGICAL, CHEMICAL AND RADIOCHEMICAL STUDIES OF MARINE PLANKTON. Progress Report for 1964. Bostwick H. Ketchum and John H. Ryther (Woods Hole Oceanographic Institution, Mass.). May 1, 1965. Contract AT(30-1)-1918. 43p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Results are reported from studies on the influence of the Amazon River on the biological productivity of the Western Equatorial Atlantic and Eastern Caribbean. The hydrographic, chemical, and biological effects of the Amazon on the surrounding ocean were studied. Data are included from a number of studies on the metabolism of phytoplankton, bacteria, algae, and other microorganisms found in the sea. Results are included from tracer studies of the nitrogen cycle, the carbon cycle, the phosphorus cycle, and pigment synthesis by marine microorganisms. A list is included of 13 papers published during the period covered by this report. (C.H.)

25840 (ORINS-49(p.63-71)) METALS METABOLISM AND MEDICAL RADIOISOTOPE DEVELOPMENT. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.).

Progress is reported in studies on the metabolism of rare earth metals in laboratory animals. Data are included from studies on the effects of Pr, La, Ce, and Nd on total liver lipids in rats. The distribution of tracer doses of ^{144}Ce in rabbits was studied, and results indicate that rare earth isotopes may have some potential in bone marrow scanning. The metabolism of Ce in yeast, Saccharomyces cerevisiae, and of ^{137}Cs and ^{137}Ba in rats was also studied. (C.H.)

25841 (UCRL-12479) AGRICULTURAL FACTORS AFFECTING THE DAILY INTAKE OF FRESH FALLOUT BY DAIRY COWS. John J. Koranda (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 19, 1965. Contract W-7405-eng-48. 34p. Dep.; $2.00(cy), 1(mn) CFSTI.

Factors affecting the grazing and feeding behavior of the dairy cow are described. Five different management methods for dairy cows are considered: continuous grazing, rotational grazing, strip grazing, soilage feeding, and storage feeding. The land area needed daily to provide feed for one cow is calculated for these five different management methods, using data from feeding and grazing studies reported in the scientific literature. It is shown that the greater area needed to support a cow by certain of these management methods is related to efficiency losses and does not imply a greater exposure of the animal to fallout-contaminated forage vegetation. A utilized area factor (UAF) is defined as the actual area producing the forage a cow will consume in one day. UAF values in m^2/cow-day are calculated for dairy cows being managed by these five different methods of grazing or feeding, on the basis of regional forage crop yields and daily forage intake values. The UAF may be used to calculate a theoretical ingested dose of fresh fallout materials from forage vegetation when the concentration of radioactivity per unit area is known. A UAF of 45 m^2/day is a reasonable median value for dairy cows grazing on continuously used pastures, and on rotational or strip pastures. If animals are being fed green-chopped forage, a UAF of 30 m^2/day is indicated. The effects of seasonal variation in crop yield upon the UAF are also demonstrated and discussed. (auth)

25842 FOLIAR, FLORAL, AND ROOT ABSORPTION OF ^{90}Sr BY CROPS. E. J. Evans and A. J. Dekker (Canada Dept. of Agriculture, Ottawa). Agron. J., 57: 82-3(1965).

In a field experiment carried out to determine the relative ^{90}Sr content of wheat, oats, alfalfa, and timothy grown in the open compared with that of the same crops grown under clear plastic tents, absorption of ^{90}Sr for the uncovered crops exceeded that of the covered for all crops. The ^{90}Sr content of flour and bran milled from wheat grown in the open was considerably greater than that of the same fractions milled from wheat that was covered at the flowering stage. However, the ratios of ^{90}Sr in the flour to that in the bran were similar in the two situations. (auth)

25843 ^{45}Ca UPTAKE AND TISSUE CALCIUM IN K-INDUCED PHASIC AND TONIC CONTRACTION IN TAENIA COLI. N. Urakawa and W. C. Holland (Univ. of Mississippi, Jackson). Am. J. Physiol., 207: 873-6(Oct. 1964).

High-potassium solutions cause tension development in skeletal, cardiac, and smooth muscle. In so-called fast striated fibers, K produces a transitory contraction (twitch), while in the slow fibers, frog's ventricle, and taenia coli, K ion induces a tonic contraction. These responses are Ca dependent. Using guinea pig smooth muscle, a comparison was made of ^{45}Ca uptake and tissue Ca changes during the two responses. The results showed that both responses were accompanied by increased entry of ^{45}Ca, the uptake being somewhat less during the twitch. In addition to an increased uptake of ^{45}Ca, a significant rise of tissue Ca was detected during the tonic response. This rise in tissue Ca was observed after 5-min exposure to high-K solution and remained elevated as long as the contracture persisted. The observation that ^{45}Ca entry remained high at all phases of the response suggests that the entry of ^{45}Ca reflects both the net gain in Ca and a continuous turnover of this fraction. The finding of no change in tissue Ca during the rapid contraction in the presence of an enhanced uptake of ^{45}Ca suggests that the entry of isotope reflects only an increased turnover of Ca during this response. However, the failure to demonstrate a change in tissue Ca under these conditions could be the result of the sensitivity of the method employed. It is noted that immediately after the twitch, ^{45}Ca entry rates were at control levels. It was proposed that in the phasic contraction, sufficient Ca is released from a cellular site to initiate contraction, whereas in the tonic contraction enough Ca crosses the membrane to initiate contraction. (BBB)

25844 THE EFFECT OF CHELATE FORMERS ON THE CONCENTRATION OF MERCURY IN THE ORGANISM. V. Nigrovic (Kernforschungszentrum, Karlsruhe, Ger.). Arzneimittel-Forsch., 13: 787-92(Sept. 1963). (In German)

After intravenous injection the greatest concentrations of ^{203}Hg are found in kidney. It is concentrated much less in spleen. These results may be related to the affinity of Hg for SH groups, and to their concentrations in various tissues. The influence of isotopic dilution and a large number of chelating agents on ^{203}Hg deposition is discussed. These include the following compounds: ethylenediamine tetraacetic acid, hexamethylenediamine tetraacetic acid, 2,2-bis[di(carboxymethyl)amino] diethyl ether, 2,2-bis[di(carboxymethyl)amino] diethylsulfide, 2,2-bis[di(carboxymethyl) amino] diethyl disulfide, diethylenetriamine pentaacetic acid, 1,2-bis[di(carboxymethyl)aminoethoxy]ethane, 1,2-bis[di(carboxymethyl)aminoethylthio]ethane, triethylenetetraamine hexaacetic acid, 1,2-diaminocyclohexane tetraacetic acid, ethylenediaminediacetic acid, iminodiacetic acid, 2-mercaptoethylimino diacetic acid, 2,3-dimercaptopropanol, 2,3-dimercaptopropionic acid, 2,3-dimercaptopropane-1-sulfonic acid, 5-mercaptopyridoxine, d-penicillamine, α-lipoic acid, triethylenetetraamine, and tetrakis-(2-aminoethyl)ethylenediamine. All of these chelating agents reduced renal deposition of carrier free ^{203}Hg, but their action on other organs and plasma concentrations were much less. Some agents increased excretion of the radioisotope. The chelating agents with sulfhydryl groups were most effective. Of all the treatments used, 2,2-bis[di(carboxymethyl)amino]diethyl sulfide, 2-mercaptoethyl iminodiacetic acid, 2,3-dimercaptopropanol, and d-penicillamine were best. Isotopic dilution of ^{203}Hg decreased renal deposition, probably because of a limited capacity of a renal compartment, and toxic effects of high doses of carrier Hg. (BBB)

25845 THE DISTRIBUTION OF RADIOACTIVITY IN DOG TISSUES FOLLOWING THE ADMINISTRATION OF THE ThioTEPA-^{32}P AS AN ADJUVANT TO SURGERY. O. Serlin and J. L. Rabinowitz (Veterans Administration Hospital, Philadelphia). Atompraxis, 11: 153-5(Mar. 1965).

ThioTEPA-^{32}P was administered as a single intraperitoneal dose of 0.6 mg/kg in one group of animals and in another group as 0.2 mg/kg intra-peritoneally and 0.2 mg/kg intravenously on two successive days. In each group of dogs, one had either laparotomy, splenectomy, partial gastric resection or combined partial gastric resection and splenectomy. There is an apparent difference in the distribution of radioactivity in the various tissues examined depending on the method of administration. The animals who received ThioTEPA-^{32}P in the multiple dose schedule had a uniformly higher pickup than those who received a single dose. In the animals receiving ThioTEPA-^{32}P as a single dose, there was increase in the concentration of radioactivity in the lungs, liver, brain, and pancreas following combined partial gastric resection and splenectomy. Partial gastric resection or splenectomy, when performed alone, did not influence the per cent concentration of radioactivity in this group. None of the above surgical procedures influenced the concentration of radioactivity in the animals who received ThioTEPA-^{32}P in the divided doses. (auth)

25846 ENERGY-COUPLING IN MITOCHONDRIA DURING RESTING OR STATE 4 RESPIRATION. Ernesto Carafoli, Carlo S. Rossi, and Albert L. Lehninger (Johns Hopkins Univ., Baltimore). Biochem. Biophys. Res. Commun., 19: 609-14(May 18, 1965).

The resting or State 4 respiration of freshly prepared, intact rat liver mitochondria can support energy-linked accumulation of Ca^{2+} or Sr^{2+} or the oxidative phosphorylation of ADP. However, under these conditions the coupling efficiency is relatively low; about 10% maximal for Ca^{2+}, about 20% for Sr^{2+} accumulation, and about 12% maximal for oxidative phosphorylation of ADP. (auth)

25847 A SENSITIVE ASSAY FOR 5-HYDROXYTRYPTOPHAN DECARBOXYLASE. Solomon H. Snyder and Julius Axelrod (National Inst. of Mental Health, Bethesda, Md.). Biochem. Pharmacol., 13: 805-6(May 1964).

5-Hydroxytryptophan decarboxylase (5-HTPD) activity is conventionally measured by manometric or fluorometric techniques, the most sensitive of which is capable of detecting the formation of 200 mμg of serotonin. A simple, sensitive, and specific radiometric assay for 5-HTPD activity is described here which involves the measurement of ^{14}C-serotonin formed from 5-DL-5-hydroxytryptophan-^{14}C. 5-HTPD activity can be routinely determined in tissues which enzymatically produce only 5 mμg of the radioactive amine during one hr incubation, and 50 assays can be performed in three hr. The reaction was linear with time for at least two hr and proportional to tissue concentration in liver over a 5-fold concentration range and in all other tissues examined. At high tissue concentrations the enzymatic activity was not linear. The product of the enzymatic activity was identified as ^{14}C-serotonin by chromatography. Specificity was determined by measurement of hepatic 5-HTPD in the presence of dihydroxyphenylalanine, a competitive inhibitor of 5-HTPD; 90% inhibition was obtained at 10^{-3}M and 63% inhibition at 10^{-4}M concentrations of the inhibitor. 5-HTPD activity was estimated in a variety of tissues. Pineal gland had the highest enzyme activity, and rat pineal exceeded bovine or quail pineal in activity. These results are in accordance with the extremely high tissue levels (20-100 μg/g) of serotonin reported for the rat pineal gland. Rat duodenum is devoid of 5-HTPD activity, whereas the jejunum and ileum have high levels. Rat uterus, which does not have measurable levels of serotonin, has an active 5-HTPD. (BBB)

25848 COENZYME BINDING BY X-IRRADIATED GLUTAMATE AND LACTATE DEHYDROGENASE. S. J. Adelstein (Harvard Univ., Boston). Biochemistry, 4: 891-6(May 1965).

The radiolysis of glutamate dehydrogenase produces an enzyme with a reduced ability to enhance the fluorescence of reduced diphosphopyridine nucleotide (DPNH). This modification is not accompanied by a decrease in the fluorescence yield per binding site nor by a reduction in the site association constant, and is consistent with an absolute deficiency in the power of the protein to bind coenzyme. An inability to bind coenzyme can also be shown by ultracentrifuge separation. With this method 31 binding sites were found per mole while 62.7 sulfhydryl groups were titrated with 4 M urea at pH 4.6. Radiolysis led to a linear relation between the loss of titratable sulfhydryl groups and coenzyme binding which suggests that specifically one of two sulfhydryl groups may be required for each DPNH molecule bound. The radiolysis of lactate dehydrogenase also resulted in a concomitant loss of coenzyme fluorescence enhancement and titratable sulfhydryl groups. The relation of both of these to activity suggests that one specific sulfhydryl is required for coenzyme binding while two groups are required for activity. Under this circumstance, the radiation inactivation of this enzyme can apparently be accounted for by sulfhydryl modification alone. (auth)

25849 PARTITION OF FATTY ACIDS OF 20-24 CARBON ATOMS BETWEEN SERUM ALBUMIN AND LIPOPROTEINS. Eleazar Shafrir, Shimon Gatt, and Sarah Khasis (Hebrew Univ., Jerusalem and Hadassah Univ. Hospital, Jerusalem). Biochim. Biophys. Acta, 98: 365-71(Apr. 5, 1965).

The distribution of free fatty acids of chain length of 16 to 24 C atoms between the albumin and lipoproteins of human serum was investigated by ultracentrifugal partition and electrophoretic separation. With elongation of the carbon chain less fatty acid was bound to albumin. More than 90% of the added palmitate remained with albumin, while the corresponding value for lignocerate was only 10 to 30%. The balance remained distributed with the lipoproteins or remained unbound. Presence of one or more double bonds resulted in an increase proportion of free fatty acids bound to albumin. The possible role of lipoproteins as carriers of free fatty acids of 20 or more carbon atoms is discussed. (auth)

25850 THE ROLE OF THE MOTHER IN ^{131}I METABOLISM OF SUCKING AND WEANLING RATS. M. Samel and A. Caputa (Inst. of Endocrinology, Czechoslovak Academy of Sciences, Bratislava). Can. J. Physiol. Pharmacol., 43: 431-6(May 1965).

In newborn rats the mother provokes the emptying of the urinary bladder by stimulating the perineum with her tongue. The possibility that mothers may thereby ingest the urine of their young was studied by means of ^{131}I on nine litters of rats aged 10 to 29 days. The results indicate that a considerable quantity of ^{131}I administered intraperitoneally to 10- and 18-day-old rats, which were then reunited with their mothers for 4 hours, reappears in the organism of uninjected nurslings after passing through the organism of the mother. The amount of ^{131}I transferred from injected rats into the bodies of isolated uninjected rats of the same litter decreased during the period of weaning. The observed recirculation of ^{131}I between immature rats and their mothers in both directions may represent a saving mechanism which might include several other substances and would compensate for their loss via the milk, and suggests a new aspect of maternal-neonatal interrelationship which appears as a continuation of the state existing in utero. (auth)

25851 CONTRACTION OF VASCULAR SMOOTH MUSCLE. David F. Bohr (Univ. of Michigan, Ann Arbor). Can. Med. Assoc. J., 90: 174-9(Jan. 25, 1964).

The role of Ca on the contraction of vascular smooth muscle was studied in rabbit aortas, comparing its action with that of other divalent cations (Sr, Ba, Mg). Isometric contractions of the muscle in reponse to addition of adrenaline or angiotensin were recorded. The following order of the divalent cations studied indicates their relative potentiating and depressing actions: (1) Potentiating: Ba >

Ca > Sr > Mg; (2) Depressing: Mg > Sr = Ca > Ba. No evidence of an enhancing action of Mg or of a depressant action of Ba was seen. Shifts of Ca concentration in either direction, from control values of 1.6 mM to 0 or to 6.0 mM, consistently led to a depression of the over-all adrenaline response. The total contraction of vascular smooth muscle in response to adrenaline is differentiable into an F- and an S-component. The F-component is normally completed within 45 sec, but the muscle continues to develop added tension for 10 to 20 min (S-component). These two components are differentially influenced by shifts in Na or K concentration. It was found that substitution of a Ca-free solution for a saline resulted in an initial potentiation of the F-component and marked depression or elimination of the S-component. Increases in Ca concentration above 1.6 mM depressed the F-component, but had little or no effect on the S-component. This is evidence that the rate-limiting event of the overall contractile process that determines the magnitude of the F-component is membrane excitability. Barium in concentrations of 0.02 mM or more caused a potentiation of the adrenaline response; the enhancement was primarily of the S-component. Magnesium produced only a depression of the adrenaline response. Strontium had a depressant effect equivalent to that of Ca, but it is only poorly able to substitute for Ca in supporting contraction. Six millimols of Sr added to the salt solution produced a depression of the adrenaline response, primarily of the F-component, an effect quantitatively similar to that produced by 6 mM Ca. Strontium in a concentration of 1.6 mM was at least minimally able to support an adrenaline response in the Ca-depleted muscle. In this it differed from Ca not only quantitatively but, apparently, also qualitatively, in that it furnished better support for the F-component than for the S-component. Deoxycorticosterone in a concentration of 0.1 mg/l or greater potentiated the adrenaline response. These observations indicate that the rate-limiting factor for the angiotensin response is membrane excitability rather than excitation-contraction coupling. (BBB)

25852 SHORT-TIME INCORPORATION OF P^{32} INTO THE MYCELIUM OF PENICILLIUM CHRYSOGENUM. I. S. Kulaev, D. Fais, A. Z. Metlitskaya, and I. A. Krasheninnikov (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 159: 198-201 Nov. 1, 1964). (In Russian)

Cultures of the mold Penicillium chrysogenum were studied. When ^{32}P was included in the culture medium for 16 sec of the growing period, it entered into the composition of many phosphorus compounds in all the fractions separated by extraction and precipitation. The absorbed phosphorus was in both labile and stable compounds and in the components of the mycelium whose phosphate was determined as "ortho." The ^{32}P was almost completely absent from nucleotides and nucleotide-containing substances. The picture was approximately the same for a 180-min growth in ^{32}P-containing medium except that a perceptible amount of radioactivity was observed in the labile fraction of the nucleotides of the alcoholic extract, although not in the ion-exchange-separated portion from some fractions. The results indicated that, in this organism, free nucleotides do not enter into the composition of the primary acceptors of the external orthophosphate. (TTT)

25853 INCORPORATION OF AMINO ACID-C^{14} FROM PHOSPHATIDE-AMINO ACID COMPOUNDS INTO CHLOROPLAST LAMELLAR PROTEINS. M. I. Molchanov, E. N. Besinger, and N. M. Sisakyan (Bakh Inst. of Biochemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 159: 202-4(Nov. 1, 1964). (In Russian)

The lamella-rich fraction of chloroplasts is more active in incorporating amino acids in lipoproteins than are whole chloroplasts. In studies with the lamella-rich fraction, the protein-synthesis inhibitor puromycin was shown to exert a negligible inhibitory action on the inclusion of amino acids in protein, and chloramphenicol did not inhibit the process during a 20-min incubation. Data obtained in earlier studies showed that with intact chloroplasts, the action of these two substances on the inclusion of amino acids in lipoproteins developed during incubation. Inhibition of the inclusion of ^{14}C-lysine in proteins by puromycin was 29% in 15 min incubation and increased to 60% in 30 min. ^{14}C-tagged valine and lysine were included in proteins of the lamella fraction in the first 5 min of incubation to the same extent whether in the free form or combined with phosphatide. With longer incubation, inclusion of the bound form increased while that of the free form decreased. The phosphatide form is therefore the active form and is apparently the form in the chloroplast. The phosphatide amino acid compounds of the chloroplasts may play an important role in cell metabolism. (TTT)

25854 UPTAKE AND TRANSFER OF CESIUM-137 BY CHLAMYDOMONAS, DAPHNIA, AND BLUEGILL FINGERLINGS. Susan F. King (Univ. of Kansas, Lawrence). Ecology, 45: 852-9(1964).

Data are presented on the uptake and transfer of ^{137}Cs by three organisms likely to be involved in an aquatic food web leading to man (an alga, daphnids, and blue gill) and the daily dosages received by these organisms after concentrating ^{137}Cs for a short time. Concentration factors of ^{137}Cs for Chlamydomonas moewusii, Daphnia pulex, D. magna, and Lepomis macrochirus fingerlings were determined following direct exposure to the isotope in solution and following ingestion of labeled food. Cesium, temperature, and algal cell concentration were varied to determine effects on ^{137}Cs uptake. Uptake of ^{137}Cs by all organisms was less at 8° than at 22°C. Chlamydomonas uptake rose with increase of available Cs in the water up to 1.0 ppM and fell with increasing algal densities. Cesium uptake by D. pulex and D. magna differed. D. pulex uptake of ^{137}Cs increased but D. magna uptake was not affected when available labeled Chlamydomonas was increased. In direct uptake studies at 22°C, D. pulex concentrated three times the amount of ^{137}Cs concentrated by D. magna. Direct uptake of ^{137}Cs by L. macrochirus was negligible, but fingerlings showed increased uptake when allowed to feed for 24 hr on labeled daphnids. Efficiency of removal of ^{137}Cs from ingested food was 21% for D. pulex, 13-14% for L. macrochirus, and 0.0% for D. magna. In a food chain study at 22°C, Chlamydomonas, at 20×10^7 cells/liter, reached a 24 hr concentration factor of 319; D. pulex, after feeding on the labeled alga for three days, had a concentration factor of 354; and the striated muscle tissue of L. macrochirus, which had fed for one day on the labeled D. pulex, had a concentration factor of 7.8. Radiation doses received by each species from ^{137}Cs decay in the water and organisms were calculated. Based on the concentration factors given in the above food chain study, Chylamydomonas received 0.11 rad/day, D. pulex 8.5 rad/day, and L. macrochirus muscle 0.38 rad/day. (BBB)

25855 FURTHER STUDIES ON THE THYROIDAL CONTROL OF RADIOPHOSPHORUS METABOLISM AS DETERMINED BY THE EFFECTS OF THYROXINE AND PITUITARY EXTRACT ON THIOUREA AND RADIOIODINE TREATED GOLDFISH, CARASSIUS AURATUS L. P. N. Srivastava (Univ. of Rajasthan, Jaipur, India). Endocrinol. Japon., 10: 190-8(Sept. 1963).

About 300 goldfish were divided into three groups. Fish of one group were injected intraperitoneally with 40, 30, 20, and 10 μC of ^{131}I for four months, one injection being given every month. One ml of fluid containing 1 mC carrier-free radioiodine was diluted to 100 ml so that each ml contained 10 μC. Histological examination of fish at the end of this period showed that all the thyroid follicles had been selectively destroyed. In the second group, the fish were similarly injected with 0.4 ml of 0.01% thiourea solution thrice a week for 2 weeks. The thyroid became hypertrophied and hyperplastic with increased number of very small follicles. The cell height was greatly increased and the colloid was either totally absent, or if present, it was highly vacuolated. The third group was maintained as control. When they were kept in aquaria with ^{32}P, the uptake after either type of treatment was similar and it was half of that of the controls. The uptake of ^{32}P in the thiourea-treated fish increased by 41.9% after acetone-dried goldfish pituitary gland injection, whereas in radioiodine-treated fish there was no significant change. Radioiodine-treated fish, when

injected with thyroxine, increased their uptake of ^{32}P by 50% but it was even then less than that of the controls. When thiourea-treated fish were injected with thyroxine, their ^{32}P uptake was restored to the level of that of the controls. The conclusion is drawn that in fishes, which lack parathyroid glands, the thyroid gland exercises a great influence over the metabolism of phosphorus and that the pituitary gland has also an indirect control through thyrotropic hormone. (BBB)

25856 THYROIDAL IODIDE TRANSPORT. VII. ACUTE STIMULATION OF THYROIDAL IODIDE CONCENTRATING ABILITY BY CYSTAMINE AND CYSTEAMINE. J. Wolff and J. E. Rall (National Institutes of Health, Bethesda, Md.). Endocrinology, 76: 949-57(May 1965).

Administration of cysteamine or cystamine to rats led to a 2- to 3-fold increase in the ability of the blocked thyroid to accumulate iodide ion. The effect occurred rapidly (< 25 min), was not mediated via the kidney or pituitary gland, and appeared not to involve a basic change in the concentration mechanism, since the Km ($\sim 3.10^{-5}$M) was unaffected by cystamine. Under special conditions, cystamine will stimulate the $Na^+ + K^+$-requiring, ouabain-sensitive ATPase activity of the rat thyroid in similar time periods. The possibility that this enzymatic activity may mediate the effect of cysteamine and cystamine on iodide concentration is discussed. In addition, these compounds possess $\sim 1/50$ the antithyroid activity of methylmercaptoimidazole. Cystamine is not goitrogenic, apparently because of the short duration of the antithyroid effect in vivo. This property appears not to be directly related to the augmentation of the the T/S[I^-]. (auth)

25857 ON THE COEFFICIENT OF ACCUMULATION OF RADIOISOTOPES OF SOME CHEMICAL ELEMENTS BY AQUATIC INSECTS. G. A. Volkova (Inst. of Zoology, Leningrad). Entomol. Rev. (USSR), 42: 280-2(July-Sept. 1963).

Data are presented on the coefficient of accumulation (CA) of 14 radioisotopes (^{32}P, ^{35}S, ^{59}Fe, ^{60}Co, ^{65}Zn, ^{90}Sr, ^{91}Y, ^{106}Ru, ^{111}Ag, ^{131}I, ^{137}Cs, ^{144}Ce, ^{147}Pm, and ^{203}Hg) by four species of aquatic insect larvae: dragonflies (Leucorrhinia rubicunda L.), mayflies (Cloeon dipterum L.), caddisflies (Glyphotaelius punctatolineatus Retz.), and drone flies (Eristalis tenax L.). In comparing the data for the four species of insects, it was found that the highest values relate to the same five elements – P, Fe, Co, Zn, and Y, although the particular element accumulated in greatest amount varied according to the species of insect. In Eristalis, for example, accumulation was greatest in the case of Y, followed by P; in mayflies, the corresponding elements were Zn and Fe, in caddisflies Fe and Zn, and in dragonflies Fe, Y, and Co. The Ca of the majority of the elements increased during the first few days; then, the CA increased gradually and after 8-16 days statistical equilibrium was established. (P.C.H.)

25858 DYNAMICS OF ACCUMULATION OF CHEMICAL ELEMENTS BY THE ALGA CLADOPHORA FRACTA AND THE DEPENDENCE OF ACCUMULATION ON CONCENTRATION OF THE ELEMENTS IN THE SOLUTION. E. A. Gileva (Lab. of Biophysics, Sverdlovsk, USSR). Fiziol. Rast., 11: 581-6(1964). (In Russian)

Labeled atoms were used for studying the dynamics of accumulation of phosphorus, sulfur, zinc, yttrium, cesium, promethium, and mercury by the fresh water alga Cladophora fracta and also the effects of concentrations of these elements on their uptake by Cladophora. It is shown that accumulation of chemical elements by Cladophora can be described by a saturation curve. The accumulation coefficients for the elements studied reach a stationary value in 2 to 7 days after the beginning of the experiment. The curve of chemical element accumulation as a function of their content in the solution is similar to the Langmuir adsorption isotherm. At low concentrations the accumulation coefficients are constant and independent of concentration of the elements in the solution (for a given physical-chemical state of the element in the solution, other conditions being the same). (auth)

25859 OCCURRENCE OF ^{54}Mn IN HUMAN AND BOVINE LIVERS. N. Irving Sax and Jack J. Gabay (New York State Dept. of Health, Albany). Health Phys., 11: 585-6 (June 1965).

The occurrence of ^{54}Mn encountered first in cow liver in Sept. 1963 and traced back to animal feed and to atmospheric contamination is reported. More than 20 human livers, obtained at autopsy, were analyzed and all showed qualitatively, the presence of ^{54}Mn. The high relative specific activity of ^{54}Mn in human and bovine livers compared to that of air samples suggests entrance into the vegetable biosphere and concentration in the liver through diet. (P.C.H.)

25860 SYNTHESIS OF TRITIUM-LABELED PROSTAGLANDIN E_2 AND STUDIES ON ITS METABOLISM IN GUINEA PIG LUNG. 37. PROSTAGLANDINS AND RELATED FACTORS. Erik Aenggard, Krister Green, and Bengt Samuelsson (Karolinska Institutet, Stockholm). J. Biol. Chem., 240: 1932-40(May 1965).

The synthesis of tritium-labeled prostaglandin E_2 is described. Enzymes in the particle-free fraction of guinea pig lung homogenates convert prostaglandin E_2 (11α,15-dihydroxy-9-ketoprosta-5,13-dienoic acid) into two metabolites. These metabolites were assigned the structures 11α,15-dihydroxy-9-ketoprost-5-enoic acid and 11α-hydroxy-9,15-diketoprost-5-enoic acid. (auth)

25861 ELECTRON MICROSCOPIC AUTORADIOGRAPHY: THE LOCALIZATION OF ^{125}I IN SUPPRESSED AND THYROTROPIN-STIMULATED MOUSE THYROID GLAND. H. Sheldon, J. M. McKenzie, and D. Van Nimwegan (McGill Univ., Montreal). J. Cell Biol., 23: 200-5(Oct. 1964).

In these experiments using radioiodine as a tracer, ^{125}I was found especially useful because its decay by K capture leads to the emission of a soft (27.4 kev) photon, particularly appropriate for autoradiography. Mice were injected intraperitoneally with 15 μC carrier-free ^{125}I and subcutaneously with 10 μg sodium L-thyroxine. Thyroid USP was added to the diet to a concentration of 0.066% to effect maximal thyroid gland suppression in about four days. On the 4th day of suppression it was found that the thyroid glands contained on average 27.5% of the dose of ^{125}I, i.e. 4.13 μC per gland. To establish that this dose of ^{125}I did not cause early radiation damage, some mice were similarly treated and maintained for two weeks on the suppressive diet. Their thyroid glands showed flat resting follicular epithelium, densely staining colloid, and no evidence of inflammation or necrosis. Thyrotropin was injected intravenously into the stimulated animals; control suppressed animals received 0.2 ml of albumin solution only. Light microscope autoradiography demonstrated intense blackening of the colloid in the thyroid follicle after four days of exposure. Autoradiographs for electron microscopy also showed large numbers of grains over the colloid material of the follicle in both suppressed and stimulated glands. Four days after the injection of radioiodide all the ^{125}I was in the follicular colloid in the suppressed animals, and 40 min after intravenous injection of thyrotropin, evidence of radioactivity was found in the follicular cells. The large cytoplasmic granules which appear in cells of the thyroid gland after the injection of thyrotropin are the principal site for the intracellular ^{125}I. Their rapid appearance and labeling with ^{125}I indicates that they are derived from the colloid of the lumen. The dose of ^{125}I used appears appropriate for electron microscopic autoradiography. No radiation effect on the cells was demonstrated. (BBB)

25862 EFFECT OF EXERCISE ON THE METABOLISM OF ^{40}CALCIUM AND OF ^{47}CALCIUM IN MAN. Charles Ragan and Anne M. Briscoe (Columbia Univ., New York). J. Clin. Endocrinol. Metab., 24: 385-92(May 1964).

Calcium-40 and ^{47}Ca turnover were studied in three human subjects maintained under standard conditions of diet and activity in a metabolic ward, each patient serving as his own control. Radiocalcium was administered intravenously in a single dose as $CaCl_2$ in a volume of 2.5 to 5.0 ml in a dose containing 35 μC of the isotope and about 1 mg of stable Ca. No patient received more than 87 μC in a 13-week period. Venous blood samples were obtained at intervals,

and urine and stool collections were made. Radiocalcium was employed to determine whether differences could be detected in relatively short experimental periods which were not observed in balance studies. Moderate exercise failed to produce consistent changes in Ca balance when the metabolism of ^{40}Ca was followed on high (50 mg/kg/day) or low (3 mg/kg/day) levels of dietary Ca. Retention of intravenously injected ^{47}Ca was induced by exercise on both diets, as evidenced by an increase in the total exchangeable Ca pool, a decrease both in the percentage of the dose excreted and in fecal specific activity, a decrease in the secretion of Ca into the intestine, and an increase in bone formation rate. There was a consistent decrease in the amount of ^{47}Ca in the feces with exercise. Since the isotope was injected intravenously, it is suggested that this decrease represents decreased secretion into the intestinal tract, and it is possible that this is secondary to a decrease in splanchnic and portal blood flow during exercise. Although an increase in so-called bone formation rate was found, it is unlikely that actual bone formation took place during the brief study periods, and this is considered only as an indication of Ca retention. It is suggested that the arithmetically derived amount of radiocalcium recovered over a period of time presents the simplest and most concrete evidence for Ca retention during exercise, since none of the assumptions concerning hypothetical pools inherent in kinetic studies are involved. (BBB)

25863 LABELING THE APPLE MAGGOT WITH STRONTIUM-89. J. W. McAllan and W. T. A. Neilson (Canada Dept. of Agriculture, Fredericton, New Brunswick). J. Econ. Entomol., 58: 168(Feb. 1965)

The results of feeding ^{89}Sr to newly emerged adults of the apple maggot, Rhagoletis pomenella, are reported. A measurable amount of labeling was retained for at least 46 days after feeding and all the flies were labeled after 6 days of feeding. (P.C.H.)

25864 SOME KINETICS OF BLASTOCYST FORMATION AS STUDIED BY THE PROCESS OF RECONSTITUTION. Joseph C. Daniel, Jr. (Univ. of Colorado, Boulder). J. Exptl. Zool., 154: 231-7(Nov. 1963).

Reconstitution of rabbit blastocysts is described as reflective of factors essential in blastocyst fluid provision by trophoblast cells. The effects of Ca, Sr, Li, and other metal ions were tested. The process can occur in vitro in a defined protein-free medium. Reconstitution in vitro occurs optimally in serum-containing media at a pH of 7.3 and at 37°C. Calcium is essential to this action, but Sr can substitute for Ca. However, Li acts as an antagonist to Ca in the reconstitutive process. Some other metal ions inhibit reconstitution. Variations of Ca concentration within the effective range (i.e. 0.4-12 mM) do not appreciably affect the rate or time of onset of reconstitution. Strontium substituting for Ca in supporting reconstitution becomes effective at the minimal concentration of 2 mM. When concentrations of 1 mM Sr and 0.1 mM Ca, neither sufficient to support reconstitution alone, are combined in the medium, they will support reconstitution. Strontium, therefore, may be considered to be only one-tenth as effective as Ca in satisfying whatever ion selector mechanisms exist for this capacity. In blastocyst reconstitution Li appears to compete with Ca for active sites, and its inhibitory effect is reversible by Ca supplementation. The effect of other cations on reconstitution was tested by adding them as the chloride salt in 3 mM concentration to the complete medium. Under these conditions Fe and Pb did not interfere with reconstitution but Cr, Mn, Co, Cu, Zn, Cd, and Ba completely inhibited it. The results are interpreted as supporting the presence of an enzymatically controlled trans-trophoblast pump operating to provide the fluid necessary for blastocyst expansion. One role of Ca might be that of an activator to one or more of the enzymes concerned. (BBB)

25865 CHANGES IN THYROID GLAND DURING LIFE-SPAN OF MICE. THYROID I RETENTION AND TURNOVER RATE. C. K. Chai, J. L. Morrison, and John L. Lenz (Jackson Lab., Bar Harbor, Maine). J. Heredity, 55: 270-5(Nov.-Dec. 1964).

Data are reported on measurements of the retention and turnover rate of ^{131}I in the thyroids of mice from three inbred strains and an outbred stock. The association of ^{131}I retention and turnover rate with age in each of the genetically different groups is examined, and the data are considered with reference to biological characteristics and aging in each of these groups. Mice from inbred strains DBA/2J, CE/Vi, LG/Ckc, and random-bred stock BCALS were used. In vivo determinations of ^{131}I retention and turnover rate were made at ten different ages, throughout the life of each animal, starting at six weeks of age. At each age, an injection of five μC of ^{131}I was given to each mouse. External thyroid and body radiation counts were begun three days after injection. Determinations made from 6 weeks to 15½ months showed that the percentage of retention of ^{131}I in the thyroid is associated with aging, declining in older ages. There were some differences in percentage of retention and in age of decline among the genetic groups. The ^{131}I turnover rate was found to increase up to middle age (about seven months) and then decline, but the change was slight. Retention dropped sharply in the CE and BCALS but comparatively slightly in LG and DBA. Mice which age relatively rapidly as indicated by declining reproductive activity and general body condition, such as the CE, also decline more rapidly in retention of thyroidal ^{131}I. The percentage of ^{131}I retention is related to the incidence of mortality in the LG mice. If the percentage of iodine retention in the thyroid is an index of physiological condition during the life of an animal, an animal at the age with higher percent ^{131}I retention is in better physiological condition. (BBB)

25866 EFFECTS OF HEAVY WATER ON ATROPA BELLADONNA. R. A. Uphaus, F. A. Crane, M. I. Blake, and J. J. Katz (Argonne National Lab., Ill.). J. Pharm. Sci., 54: 202-5(Feb. 1965).

The growth of belladonna is strongly inhibited by D_2O concentrations greater than 50%. The alkaloid content decreases progressively as the deuterium level in the plant increases. Germinative ability of seeds containing up to 40% deuterium was unimpaired. (auth)

25867 INDUCTION OF REVERSIBLE AND IRREVERSIBLE PATTERNS OF RENAL FAILURE: A REPRODUCIBLE LABORATORY PREPARATION IN THE DOG. Jack Nayman (Univ. of Melbourne). J. Surg. Res., 4: 82-91 (Feb. 1964).

After investigating several nephrotoxic agents, uranyl ion was chosen as the optimal agent for inducing renal lesions in the dog. Mercury bichloride, potassium dichromate, and uranium nitrate are all crystalline substances, the ions of which pass easily through the glomerular filter. By absorption of water from the glomerular filtrate they become concentrated in the tubules and cause necrosis of the lining epithelium. Uranium nitrate was chosen as the agent to induce renal failure in preference to mercury bichloride and potassium dichromate because of a decreased toxic potential on a weight basis. It is the metallic ion that injures the epithelium and the cellular damage is proportional to the concentration of metal. One milligram of $K_2Cr_2O_7$ contains 6.80×10^{-3} g at. of Cr; 1 mg $HgCl_2$ contains 3.66×10^{-3} g at. of Hg, and 1 mg $UO_2(NO_3)_2$ contains 2.53×10^{-3} g at. of U. This relatively decreased toxic potential results in a less severe reaction and therefore allows a more prolonged type of uremic pattern to be produced. The anhydrous form of uranium nitrate was used; this is inexpensive and stable in a simple solution. The action of U is selective and specific. It causes precipitation of protein in the cells lining the tubules and requires a pH which is equivalent to that in the tubules. A dosage scheme calculated on the basis of 5 mg/kg body weight was used. It was administered in a solution of normal saline, containing 5 mg of uranium nitrate (anhydrous salt) per ml. The patterns of irreversible and reversible varieties of acute renal failure are presented. An irreversible pattern can be induced by increasing the dose, whereas the reversible pattern observed is probably determined by natural specific animal selectivity and by external temperature. The histo-

logic changes are considered in relation to the glomeruli, tubules, and interstitial tissue. The glomeruli are not involved and maintain their structure throughout. The tubules in the reversible group show three distinctive patterns. The first is that of tubular necrosis and is associated with exudate formation; second is that of regeneration, which is associated with recovery, and third, that of gross dilatation with almost total loss of cellular composition, but absence of exudate formation and associated with death. It is only after successive episodes of renal failure that the interstitial tissue becomes involved. As a terminal feature edema and cellular infiltration are pronounced. This technique was applied to rabbits, rats, and guinea pigs. Irreversible patterns of renal failure resulted using appropriate doses of uranium nitrate; however, the patterns of reversible renal failure could not be produced in these small animals. (BBB)

25868 COMPARISON OF STRONTIUM-90 LEVELS BETWEEN ANTLER AND MANDIBLE OF WHITE-TAILED DEER. Vincent Schultz (Atomic Energy Commission, Washington, D. C.). J. Wildlife Management, 29: 33-8 (Jan. 1965).

Strontium-90 concentrations of antlers and mandibles (plus teeth) collected from 18 white-tailed deer (Odocoileus virginianus) were compared to evaluate the feasibility of utilizing antlers to establish strontium-90 fallout levels during the period of antler development. As there was a significant correlation (computed $r = 0.74$; $r_{.01}$ (16 df) = 0.59) between antler and mandible level it was concluded that the strontium-90 content of an antler is influenced by bone level; therefore, not a reliable indicator of amount of radionuclide consumed during the antler growth period. The overall average strontium-90 content of mandibles was not significantly different from that of antlers. Further, differences between mandibles and antlers were independent of age of deer. (auth)

25869 RELATIONSHIP OF SEX AND AGE TO STRONTIUM-90 ACCUMULATION IN WHITE-TAILED DEER MANDIBLES. Vincent Schultz (Atomic Energy Commission, Washington, D. C.) and Vagn Flyger. J. Wildlife Management, 29: 39-43(Jan. 1965).

Mandibles (plus teeth) of 68 white-tailed deer (Odocoileus virginianus) of various age-classes were collected in December, 1959, at Aberdeen Proving Ground, Maryland, to study strontium-90 distribution within a deer herd. No statistically significant difference was observed in the mean strontium-90 accumulated by males and females, but there was a significant difference between age-classes. Further, there was no significant age-class-sex interaction, implying that the difference between age-classes was independent of sex. The amount of strontium-90 in the mandible was correlated with year of birth and the annual strontium-90 increment and total strontium-90 in the soil. There were no statistically significant differences between the variances of the age-classes of either sex. Considerable variation in the strontium-90 content of mandibles within age-classes was observed. (auth)

25870 STRONTIUM METABOLISM AND ^{90}Sr POISONING. A. Schmid and K. Zipf (Universitat, Munich). Med. Ernaehr., 3: 80-2(Apr. 1962). (In German)

The physical, radiochemical, and radiobiological characteristics of ^{90}Sr are reviewed. Methods of production, and its distribution in the stratosphere, geosphere, and biosphere are described. Units of measurement, observed ratio, and discrimination factor are defined. Characteristics of ^{90}Sr incorporation are detailed. These include mechanisms of oral uptake, contamination from ingested foodstuffs, discrimination in gastrointestinal resorption, resorption velocity, degree of resorption, and range of variation of resorption. Uptake of parenterally administered ^{90}Sr and its blood plasma concentration are discussed. Several aspects of the metabolism of ^{90}Sr in bone are considered: velocity and degree of incorporation, distribution and turnover, toxic effects of nonradioactive Sr, and spontaneous or induced elimination of ^{90}Sr from the skeleton. The radiation burden from deposited ^{90}Sr, and its acute and chronic toxicity are discussed. Excretion of ^{90}Sr in urine, feces, milk, bile, pancreatic juice, saliva, and eggs are compared. Transmission of ^{90}Sr to plant and animal progeny is reviewed. (217 references) (BBB)

25871 PROLIFERATION AND MATURATION DEFECT IN ACUTE LEUKAEMIA CELLS. F. Gavosto, A. Pileri, C. Bachi, and L. Pegoraro (Universita, Turin). Nature: 203: 92-4(July 4, 1964). (EUR-973.e)

The incorporation of tritiated thymidine was evaluated in the blast of normal and leukemic bone marrow. It was observed that the higher percentage of blasts the lower the proliferative capacity tended to be. Within the same blastic population of acute leukemia cells, subdividing the elements into various classes according to the different diameter, a positive linear relationship was observed between the cell diameter and the incorporation percentages. In two cases of acute leukemia injected in vivo with tritiated thymidine, a similar heterogeneity in the incorporation rate was observed. In subsequent samples it was observed that in the classes with the highest diameters the percentage of labeled cells dropped rapidly in the first 24 hours while in the classes with the smallest diameters the percentage of labeled cells gradually increased. The aging of a population of blasts having lost any differentiative capacity therefore involves a progressive loss of their proliferative potentiality. (auth)

25872 DEIODINATION OF ROSE BENGAL-^{131}I IN VITRO BY RAT ORGAN HOMOGENATES. P. Raban, M. Jirsa, and V. Gregora (Charles Univ., Prague). Physiol. Bohemoslov., 13: 462-6(1964).

The dye rose bengal was obtained in a pure form by adsorption chromatography and labeled with ^{131}I. When it was incubated at 37°C with rat organ homogenates (heart, skeletal muscle, liver), it was found, as in experiments in vivo that ^{131}I was split from the rose bengal molecule, the values being highest in heart homogenate and lowest in liver homogenate. It is suggested that the course of deiodination of rose bengal is similar to that of deiodination of thyroid hormones and the experiments were therefore conducted under conditions originally described for the deiodination of these hormones. Since heart homogenate displayed the greatest ability to split off iodine and liver homogenate the least, the amount of ^{131}I split off after the intravenous administration of rose bengal-^{131}I was determined more by the time it persisted in the blood stream than by the direct action of the liver. Since deiodination occurred in both native and boiled homogenates (heating heart homogenate at 100°C had no effect, while the degree of deiodination was actually higher in boiled muscle and liver homogenate), the participation of a sensitive intact enzymatic system cannot be presumed. The findings indicate that a thermostable factor present in the test organs in different concentrations is responsible for deiodination. (TCO)

25873 INFLUENCE OF FOLIAR CHARACTERISTICS ON THE ABSORPTION OF A RADIOACTIVE MODEL COMPOUND BY APPLE LEAVES. Shoji Kamimura and Robert N. Goodman (Univ. of Missouri, Columbia). Physiol. Plantarum, 17: 805-13(1964).

The influence of some morphological characteristics of apple leaves on their absorption of ^{14}C-labeled leucine was studied. The labeled amino acid was applied by means of a glass well affixed to the leaf surface. The results revealed that lower leaf surface absorbed 3–5 times as much as the upper surface, reflecting perhaps the influence of a thinner cuticle and stomatal openings. Position of a leaf on a shoot also affected leucine absorption, as leaves near the apex absorbed less than those nearer the base. Discontinuities and cracks in the cuticle of the older leaves may explain this phenomenon. Differences in absorption between position on an individual leaf, with respect to apex vs base and veinal vs interveinal regions, were also noted. Greater absorption of leucine was noted at apical and interveinal positions on the leaf. It was not possible to invoke translocation away from the point of application to explain reduced absorption in the region of major veins. (auth)

25874 EFFECT OF THE STRONTIUM–CALCIUM RATIO ON THE DISTRIBUTION OF STRONTIUM AND CALCIUM IN PISUM SATIVUM. C. Myttenaere (CEN,

Mol, Belg.). Physiol. Plantarum, 17: 814-27(1964). (In French). (EUR-990.f)

The physiological distribution of Sr and Ca is a function of the Sr/Ca ratio in the nutrient solution. The lower the Sr/Ca ratio is, the higher is the quantity of Sr fixed on the walls. The proportions of Ca and Sr found in the cell walls and in the cell sap are equal when ratio in the nutrient solution is one. In the walls part, Sr is not only chemically fixed (pectate i.e.) but a certain fraction is exchangeable. As previously reported for Ca, these results would confirm the theory of the translocation of Sr by exchange. The discrimination made by animals between Ca and Sr could partly be due to the ingested plant material (passive discrimination) and to the animal (active discrimination). (auth)

25875 A COMPARISON OF STABLE STRONTIUM AND P^{32} AS TRACERS FOR ESTIMATING ALFALFA ROOT ACTIVITY. R. L. Fox (Univ. of Nebraska, Lincoln) and R. C. Lipps. Plant Soil, 20: 337-50(June 1964).

The use of stable Sr was compared with ^{32}P as a tracer to indicate root activity of alfalfa growing on two soils. The alfalfa was sub-irrigated from water tables 8 and 12 feet below the surface. Two methods of application of the Sr tracer were compared: application of $SrCl_2 \cdot 6H_2O$ in small holes at various depths from the surface to the water table; and mixing of the Sr-salt with soil before placement in large holes. Although a greater amount of Sr was taken up from applications mixed with soil and placed in one large hole per square foot, the Sr-uptake data was more uniform from placement made in four small holes per square foot. Estimates of root activity using Sr agreed in general with estimates from the use of ^{32}P. Three zones of activity were evident: high activity in the surface horizons that received intermittent moisture from rainfall; a zone of moderate activity associated with ample capillary moisture above the water table; and low activity associated with poor chemical environment and/or inadequate moisture between zones 1 and 2. Phosphorus uptake, and thus estimated root activity, was very meager from the cold soil of the capillary zone during the early season. Uptake increased greatly during the growing season. Strontium uptake from the capillary zone followed the same trend as for ^{32}P uptake, but early uptake was evidently less dependent upon temperature. Evidence of winter root activity was seen in the abnormal amounts of Sr in first growth alfalfa from plots that received deep applications of strontium. Evidence on the detrimental effects of excessive and early clipping on deep root activity was seen in decreased Sr-uptake from deep-placed Sr-tracer following a year of heavy sample taking. Some factors to be considered in interpretations of tracer data are discussed. (auth)

25876 HISTORADIOGRAPHIC DETECTION OF CALCIUM-45 IN PHLOEM OF CUCURBITA MIXIMA. Walter Eschrich (Universitat, Bonn), Berthilde Eschrich, and Herbert B. Currier. Planta, 63: 146-54(1964). (In German).

Previous studies have indicated that Ca is immobile in the phloem of plants. However, the present experiments indicated that under certain conditions Ca is accumulated in the region of the sieve tube callose. The experiments were conducted with plants grown in Hoagland media to which was added 15 μC $^{45}CaCl_2$ per 100 ml of solution. After 18-hr growth in the radioactive medium the plants were frozen-dried and examined by autoradiography. The results showed that ^{45}Ca taken up by the roots of C. mixima is distributed throughout the entire plant, moving only in the apoplast. Historadiographs showed that newly deposited sieve tube callose takes up ^{45}Ca. The isotope is bound there in a poorly soluble compound. Sieve tubes, prepared by freezing the entire plant, showed no callose activity. Only the newly deposited sieve tube callose, which occurs after cutting the vascular bundle, takes up ^{45}Ca. It is concluded that organic phosphorus compounds, liberated during callose deposition, combine with Ca to form a less soluble salt. The organic P compounds are abundantly present in the sieve tube, and are presumably involved in callose synthesis. The liberation of free phosphate from these compounds by enzymes present in this site allow the formation of insoluble salts from the Ca which is present. The Ca ions accelerate the polymerization of callose constituents, which in turn frees phosphate for salt formation. (BBB)

25877 UPTAKE AND TRANSLOCATION OF RADIOACTIVE IRON AND ZINC BY TRIFOLIATE ORANGE AND ROUGH LEMON. A. Khadr and A. Wallace (Univ. of California, Los Angeles). Proc. Am. Soc. Hort. Sci., 85: 189-200(1964). (TID-20093)

Citrus trees grown on trifoliate orange rootstock are very susceptible to iron and zinc deficiencies. A number of studies with ^{59}Fe and ^{65}Zn were conducted in solution culture with seedlings and small grafted plants to compare trifoliate orange with rough lemon, a species that is very resistant to Fe and Zn deficiencies. Special precautions were taken to remove unabsorbed ^{59}Fe and ^{65}Zn from root surfaces after the tests were completed but before assay. Nearly all of the tests indicated that at low concentrations of Fe and Zn, rough lemon not only absorbed more of either isotope but also translocated more of each to leaves than did the trifoliate orange. At high external concentrations the difference disappeared for Fe but did not for Zn that was translocated to leaves. The results generally indicated that Fe and Zn translocation from roots to leaves may be a more important problem than absorption. Phosphate and bicarbonate were especially inhibitory of Fe translocation with trifoliate orange. High Ca levels decreased iron uptake by both species. Temperature and metabolic inhibitor studies did not differentiate particularly between the 2 species although there were some interactions. (auth)

25878 ON THE PROBLEM OF ACCUMULATION AND EXCRETION OF INCORPORATED PHOSPHORUS FROM EYE TISSUES. Ts. P. Medvedovskaya and I. A. Likhtarev (Inst. of Industrial Hygiene and Occupational Disease, Kiev). Radiobiologiya, 5: 213-17(1965). (In Russian)

Experimental data were obtained that justified the selection of a complex exponential model of the accumulation and release of radioactive isotopes from eye tissue. The effective and biological half lives of ^{32}P were determined. The data indicate the possibility of calculating the activity in the rabbit eyeball resulting from administration of radioactive phosphorus in concentrations close to those used in the experiment. The dose load in the eye tissue may then be estimated without repeated experiments. (tr-auth)

25879 ACCUMULATION OF RADIOISOTOPES IN ROE OF THE BLACK SEA FISH. V. N. Ivanov (Inst. of Biology of the South Seas, Sevastopol, USSR). Radiobiologiya, 5: 295-300(1965). (In Russian)

Distribution coefficients were determined for ^{90}Sr, ^{90}Y, ^{91}Y, ^{144}Ce, ^{137}Cs, ^{95}Zr, and ^{106}Ru in the developing roe of Black Sea fish. The ^{90}Y, ^{91}Y, and ^{144}Ce showed a much greater accumulation than the others. Yttrium-90, ^{91}Y, ^{144}Ce, and ^{106}Ru localized in the egg casings and the other nuclides in the embryonic tissue. (tr-auth)

25880 ON THE ACCUMULATION AND DISTRIBUTION OF ^{90}Sr IN DOGS BY ADMINISTERING OF THE ISOTOPE THROUGH THE MOUTH. B. N. Annenkov. Radiobiologiya, 5: 316(1965). (In Russian)

Five puppies were each fed 0.4 μC of $^{90}SrCl_2$ solution daily for a year and then sacrificed. The percentage of ^{90}Sr in the skulls was twice that in other bones examined and 3000 times that in soft tissues. About 23% of the total administered dose was present in the skeletons and 0.1% in the soft tissues. (IIC-M.G.)

25881 TOXICITY OF TRITIUM OXIDE. D. I. Zakutinskii, Z. N. Nakhil'nitskaya, and I. K. Petrovich. Radiobiologiya, 5: 318(1965). (In Russian)

Tritium oxide administered subcutaneously to mice, rats, and rabbits was lethal at doses of 1 μc/g. Smaller doses caused changes in the peripheral blood. This was found to be of interest because of the widespread use of tritium as a tracer. (IIC-M.G.)

25882 COEFFICIENTS OF ACCUMULATION AND DISTRIBUTION OF ^{106}Ru IN ORGANS AND TISSUES OF SEA MOLLUSKS. A. Ya. Zesenko and G. G. Polikarpov (Inst. of Biology of South Seas, Sevastopol, USSR). Radiobiologiya, 5: 320-2(1965). (In Russian)

Analysis of data on the distribution of ^{106}Ru in mussels showed 65% in the shell and 30% in the byssus. The mollusk possibly plays a significant role in filtering ^{106}Ru from shallow sea water. (IIC-M.G.)

25883 RADIOACTIVE STRONTIUM: ESTIMATION OF THE AMOUNT ACCIDENTALLY INGESTED. Joseph Samachson and Herta Spencer (Veterans Administration Hospital, Hines, Ill.). Science, 148: 955-7(May 14, 1965).

If radioactive strontium is accidentally ingested or inhaled, the amount absorbed may be calculated with reasonable accuracy from the amount of calcium and strontium excreted in the urine in a single day. The amount retained by the body initially may be calculated from the amount of radiostrontium excreted in the feces in the first few days. (auth)

25884 EFFECT OF ACIDIC POLYSACCHARIDES ON BONE UPTAKE OF RADIOACTIVE STRONTIUM AND CALCIUM. T. M. Paul, D. Waldron Edward, and Stanley C. Skoryna (McGill Univ., Montreal). Surg. Forum, 15: 66-7 (1964).

An attempt was made to inhibit absorption of radiostrontium (^{89}Sr) from the gastrointestinal tract of rats and thus reduce its deposition in bone by using nonabsorbable, nontoxic, macromolecular polysaccharides of seaweed origin. These include 2 uronic acid polymers, polymannuronic acid, and polygalacturonic acid; and a sulfated acid (carrageenin). The effect of these binding agents on nutritionally essential Ca was also studied in R.V.H. strain rats. One mg sodium alginate was dissolved in 0.5 ml. water containing 2 μC ^{89}Sr or ^{45}Ca. Inert $SrCl_2$ (0.9 μM/ml) or inert $CaCl_2$ (1.1 μM/ml) were included respectively: 0.5 ml of the test solution was injected into the ligated intestinal segments of rats. In all experiments it was noted that the maximum rate of absorption for both radionuclides occurred from the duodenal segment. In the control series, after 30 min about 70% of ^{45}Ca was absorbed from the duodenum whereas only about 30% of ^{89}Sr was absorbed. Towards the distal jejunal and ileal segments the rate of absorption for both elements had declined from one-half to one-third of that from the duodenal segment. A corresponding pattern was noted in bone uptake and in blood levels of these radionuclides. By adding 1 mg of sodium alginate to the test solution of ^{89}Sr, deposition of ^{90}Sr in bone was reduced by 50 to 70%; a similar reduction was noted in the blood level. At this concentration of binding agent, there was no significant reduction in ^{45}Ca deposition in bone, nor was there any effect on percentage absorption or in blood level of ^{45}Ca. By increasing the quantity of binding agent to 10 mg/ml it was possible to reduce ^{89}Sr deposition in bone to less than 10% of the control. Preliminary studies with other acidic polysaccharides such as polygalacturonic acid show similar effects. It is concluded that despite the physico-chemical similarity of Ca and Sr, there exists a group of naturally occurring polysaccharides which have a relatively selective inhibitory action on the gastrointestinal absorption of radioactive Sr with resulting significant lowering of bone deposition. Therefore, these materials may be used to prevent the body burden of radioactivity due to ^{90}Sr. (BBB)

25885 QUANTITATIVE MEASUREMENT OF TRANSPLANTATION IMMUNITY. John S. Najarian and Joseph D. Feldman (Univ. of California, San Francisco). Surg. Forum, 15: 127-8(1964).

Exploratory studies were made in attempts to develop a new radiometric technique for evaluation of transplantation immunity. Thus, these experiments were designed to determine if passive transfer of radioactively labeled homologous cells could be used as a technique of quantitation of homograft rejection. The radioactivity in the spleen of recipient animals was measured from one hour to days after intravenous injection of ^{3}H-thymidine-labeled isologous or homologous spleen cells. Labeled spleen cells were obtained from donor mice given ^{3}H-thymidine three times daily for three days. The total number of cells and the total radioactivity in donor suspensions were calculated from aliquots. Intravenous injections of 10^8 cells were made into isologous and homologous recipients, and into homologous recipients presensitized to the tissues of donor mice. Three recipient mice were killed at regular intervals after cell transfer. Lymphoid and other organs were removed to measure ^{3}H content, which was expressed as a percentage of injected dose per g of tissue. Six to eight hr after cell transfusion, radioactivity reached its maximum in the recipient spleens. Thereafter, the rate of disappearance declined in a straight line of decay when the data were plotted on semilogarithmic paper. The half-life (T/2) values of the labeled cells (antigen) were 70 to 96 hr in isologous recipient spleens, 36 to 44 hr in homologous recipient spleens, and 12 to 20 hr in homologous presensitized recipient spleens. It is concluded that a technique of quantitating transplantation immunity, utilizing passive transfer of labeled cells, has been demonstrated. (BBB)

25886 ABSORPTION, SECRETION, AND EXCRETION OF FALL-OUT RADIO-NUCLIDES IN FARM ANIMALS. J. van den Hoek (Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen, Netherlands). Tijdschr. Diergeneesk., 88: 627-52(1963). (In Dutch)

A detailed review is given of the absorption, secretion, and excretion of fallout radionuclides in farm animals. After a brief discussion of the principle of nuclear fission, the physical and biological properties of the radionuclides thus formed, the distribution of fallout in the atmosphere, the soi-chemical and botanical aspects, and the phenomena of absorption and excretion of ^{131}I, ^{90}Sr, and ^{137}Cs in farm animals are extensively reviewed. Special attention is given to the secretion in milk and to the factors that influence this secretion. (auth)

25887 A STUDY OF THE POSSIBLE CARCINOGENICITY OF IRRADIATED FOODS. J. L. Radomski, William B. Deichmann, B. S. Austin, William E. MacDonald, and E. Bernal (Univ. of Miami, Coral Gables, Fla.). Toxicol. Appl. Pharmacol., 7: 122-7(Jan. 1965).

This study was designed to determine whether γ irradiation of food for sterilization is likely to increase its carcinogenicity. Although no significant radioactivity is induced in the food, chemical changes may be produced by this exposure, including highly reactive free radicals. Male and female mice (2834) of four different strains, namely DBA, Swiss, C_3H, and $C_{57}Bl$ were fed for the duration of their life a mixture of foods (fruit compote, beef, tuna fish, sweet potato, and corn), irradiated with 5.58 Mrad of γ radiation. At the death of these animals, each was subjected to a careful examination. All tumors found were examined histopathologically and were classified. Analysis of the tumor incidence of the mice fed the control diet and the mice fed the irradiated diet showed that there was no significant difference between the two groups. In some instances the incidence of a particular tumor, such as lymphoma, in Swiss males was higher in the irradiated diet group, but on the other hand, the incidence of this same type of tumor was higher in C_{57} females on the control diet. The primary types of tumors found were bronchogenic carcinoma, mammary carcinoma, malignant lymphoma, and hepatoma. In addition, an isolated case or two of carcinoma of the stomach, carcinoma of the fallopian tubes, hemangioma, fibroma, carcinoma of the pancreas, carcinoma of the uterus, papilloma of the skin, myxoma, hemangioma of the liver, carcinoma of the skin, and sarcoma of the skin were observed. The incidences of these various tumors were similar in the animals fed irradiated and control diets. As expected, the incidence of mammary carcinoma was high in the female C_3H and DBA mice. Comparing the total number of mice in each group with malignant tumors, it is concluded that the irradiated diet did not have a carcinogenic effect on these strains of mice. (BBB)

25888 QUANTITATIVE IN VIVO INVESTIGATIONS OF THE SPECIFICITY OF THE REDUCTION OF THE ^{131}I

WHOLE-BODY RETENTION BY MEANS OF INHIBITORS OF IODIDE INCORPORATION. H. C. Heinrich and E. E. Gabbe (Universitat, Hamburg). Z. Naturforsch., 20b: 54-61 (Jan. 1965). (In German)

The structure specificity of the inhibition of the $^{131}I^-$ incorporation and concentration by equimolecular amounts (p.i mMole) of monovalent anions was determined on rats quantitatively and in vivo by kinetics of the ^{131}I whole-body retention. Measurement of the ^{131}I whole-body retention took place in a large-area radioactivity detector with liquid organic scintillators. The fraction of the ^{131}I test mass converted after attainment of metabolic equilibrium of the resorbed $^{131}I^-$ in the whole-body iodine pool with the constant biological half-life of the organically bound iodine (~10 days), the so-called ^{131}I labeling fraction of the organically bound iodine pool, is a suitable reference system for the measuring of the inhibitor effect of monovalent anions on the $^{131}I^-$ incorporation and concentration. If the theoretical possible inhibition effect is -100%, the most effective inhibitors were 10_4^- (-91%), 10_3^- (-92%), and ClO_4^- (96%), the average inhibitor was SCN^- (-70%), and the poorest inhibitors were NO_3^- (-28%) and ClO_3^- (-30%). None of the monovalent ions investigated decreased the labeling fraction of the organically bound iodine pool and the ^{131}I whole-body retention more than an equimolecular mass of iodide (-97%), which leads to an extensive saturation of the iodide incorporation and concentration mechanism. (tr-auth)

25889 THE USE OF FINE-RESOLUTION AUTORADIOGRAPHY IN NEUROLOGICAL AND PSYCHOBIOLOGICAL RESEARCH. Joseph Altman (Massachusetts Inst. of Tech., Cambridge). p.336-59 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Studies made on the use of fine-resolution autoradiography in determining the aspects of neural organization and function are described. The autoradiographic technique, which is described, was used to investigate regional nucleic acid and protein metabolism under normal conditions in the brains of cats, rats, chickens, and pigeons, as well as alterations from normal metabolic patterns as a consequence of pathological brain processes or variations in the physiological state of laboratory animals. (P.C.H.)

25890 NEWER ASPECTS OF BRAIN LIPIDS IN RADIATION STUDIES. James F. Mead (Univ. of California Center for Health Sciences, Los Angeles). p.360-4 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Studies were made to test the hypothesis that very unusual long-chain fatty acids containing odd numbers of carbon atoms (C_{21}, C_{23}, etc.) and hydroxy groups on the alpha carbons might be degradations products of the very long-chain acids formed in a scheme completely different from the usually accepted beta oxidation. Preweanling rats were injected with carboxy-labeled acetate, and after a period of five months the odd-chain fatty acids were isolated, and the location of the active carbons was determined. Although the results were not as clear cut as was hoped they would be, it was found that the starting hypothesis appears to be a reality. Thus, the brain has a different system for degrading fatty acids — alpha-oxidation rather than the well-known beta-oxidation system. (P.C.H.)

25891 ISOTOPIC DETERMINATION OF BODY COMPOSITION IN MAN. Nathaniel I. Berlin and William E. Siri. p.34-53 of "Progress in Atomic Medicine. Vol. I." New York, Grune and Stratton, 1965.

The use of radioisotopes in determining body composition in man, which includes body fluid compartments, mineral components, plasma proteins, and body compartment systems, is reviewed. 101 references are included. (P.C.H.)

25892 FREE RADICALS AND PARAMAGNETIC IONS IN BIOLOGICAL SYSTEMS. Wallace Clayton Snipes. Thesis, Durham, N. C., Duke Univ., 1964. 115p.

Water vapor altered the form and greatly increased the rate of decay of the electron spin resonance pattern of long-lived free radicals obtained upon gamma irradiation of Artemia salina cysts (brine shrimp eggs). These results, combined with data on radiation survival, indicate that the water vapor protects the cysts from radiation damage or heals the damage. Strong, well-resolved electron paramagnetic resonance spectra of Mn^{++} were observed in samples of maple leaves and pine needles just removed from the tree. This signal decayed rapidly as water evaporated from the sample indicating that tumbling motions of the manganese ion-water complexes effectively average away anisotropic contributions to the hyperfine structure. The detection of these tumbling motions by electron paramagnetic resonance may be used to monitor periodic variations of water content as well as transitions between the bound and unbound states of water in plants. Absorbed oxygen was shown to be responsible for the singlet electron spin resonance pattern having a g value of 2.00 observed in dry maple leaves and pine needles. This singlet ESR pattern probably arises from a peroxide radical formed upon attack by oxygen of some molecule in the plant cell. A mechanism is proposed for the decay or rotting of plant materials based on this attack by oxygen of certain molecules or certain parts of molecules in the plant followed by reaction with water of the peroxide radical formed. An eight-component hyperfine pattern was observed in some commercial samples of RNA, which resembles that of VO^{++} ion in solution. These anomalies for solutions have been explained on the basis of tumbling motions of the ions. (Dissertation Abstr., 25: No. 5, Nov. 1964)

25893 MATERNAL AND INFANTILE METABOLISM OF CESIUM. L. G. Bengtsson, Y. Naversten, and K. G. Svensson (Univ. of Lund, Sweden). p.21-32 of STI/PUB/84 (Vol.II).

Investigations concerning the cesium metabolism of three women from late pregnancy to some months after partus are reported. In two cases, biological half times of about 30 d were found, in contrast to the half times of about 70 d that are usually found. The transfer of activity from mother to child via placenta and later via breast milk was investigated in the three cases. The specific activity of the infant was, at partus, close to that of its mother. A biological half time for cesium in children of only 25 d was obtained in two cases. Both cesium-137 and cesium-132 were used for the investigations. The radiation doses to the subjects from these isotopes were very small and comparable with the monthly doses from body potassium. (auth)

25894 THE METABOLISM OF CESIUM IN MAN. K. Liden (Univ. of Lund, Sweden). p.33-40 of STI/PUB/84 (Vol.II.).

A review is presented on the distribution, gross metabolism, uptake and excretion, and transfer of ^{137}Cs in man. (P.C.H.)

25895 DISTRIBUTION OF CESIUM-137 IN SAMPLES CONSISTING OF SOFT TISSUE, BONE AND BONE-MARROW (PRELIMINARY RESULTS). U. Nay, W. Stahlhofen, and A. Kaul (Max-Planck-Institute for Biophysics, Frankfurt am Main). p.49-60 of STI/PUB/84 (Vol.II).

The concentration of cesium-137 in compact bones as well as in bone marrow was determined. Furthermore, the concentration of cesium-137 in the soft tissue of the same individuals was measured. Data are tabulated. (P.C.H.)

25896 THE RETENTION AND EXCRETION OF CESIUM-137 BY TWO MALE SUBJECTS. R. Hesp (United Kingdom Atomic Energy Authority, Sellafield, Cumb., Eng.). p.61-74 of STI/PUB/84 (Vol.II).

A whole-body counter was used to make a series of in vivo measurements of body radioactivity on two male employees who had received accidental intakes of radioactive material. The contaminant consisted mainly of cesium-137, although small amounts of other radionuclides were also present. Body radioactivity determinations were made on the two men, during periods of 1 to 289 d and 10 to 169 d after the day of intake, and the results indicated that the initial intakes of cesium-137 were approximately 0.59 and 0.15 μC. The effective half times for the long component of body retention were 116 and 68 d, respectively. In the case of the man with the highest intake, the long component

represented about 78% of the initial body burden. The distribution of cesium-137 in his body was measured on two occasions within fourteen days of intake, and about 15% of the retained body burden was dound to be concentrated into a small volume in the region of the chest. Urine samples from both subjects were analyzed for cesium-137. From the equations describing the pattern of excretion in urine, and retention of cesium-137 in the body, it was possible to make estimations of the cesium-137 excreted in faeces. After the fifteenth day following intake, the average amount of cesium-137 excreted per day in urine represented about 0.55% of the retained body burden. During the same period the average urinary to fecal ratio was approximately 2.3. (auth)

25897 HALF-LIFE STUDIES OF RADIOCESIUM IN HUMANS. Y. Naversten and K. Liden (Univ. of Lund, Sweden). p.79-87 of STI/PUB/84(Vol.II).

The retention of cesium-137 in humans was studied in several cases. Two adult men were intravenously administered a small quantity of cesium-137. They were followed about 300 days by frequent whole-body counting and with excreta collection during the initial period. The retention decreased as a sum of two exponentials. The slowest compartment decreased with a halflife of about 75 d. One of them was also given cesium-137 orally 2 years later with the same excretion pattern obtained as after intravenous injection. The excretion rate of cesium-137 was also studied in a different way for large groups of men, women, and children through comparison with diet data. From a group of 10 people, voluntarily changing their diet, the average excretion rate could be calculated from whole-body counting at an interval of six weeks. The excretion also was obtained from a study on two people after an oral administration of cesium-132. Detailed results are given, particularly with respect to the elimination rate of cesium, i.e. the biological half life and its variation with sex and age. On the average, half lives ranging from 30 to 90 d were obtained. (auth)

25898 THE STUDY OF BINDING AND DISTRIBUTION OF CESIUM-137 IN THE BLOOD. D. Djuric, V. Visnjic, M. Kilibarda, Lj. Novak, and S. Zivancevic (Inst. of Occupational Health, Belgrade). p.97-102 of STI/PUB/84(Vol. II).

Studies were made to try to establish the character of binding and distribution in the fractions of the blood for cesium-137. In vitro experiments were performed with cesium-137 sulfate in the blood of rats. During these experiments the time and temperature of incubation was varied and it was established that: the greatest part of radioactivity is in the plasma of the blood; with increase of the time of incubation the radioactivity of the blood cells increases; and with increase of the temperature the same effect is obtained. The results are discussed in the light of the chemical and physical theories of binding. Results on the distribution of cesium-137 in the fractions of plasma and erythrocytes are mentioned. (P.C.H.)

25899 CESIUM-137 CHLORIDE RETENTION FOLLOWING ACCIDENTAL INGESTION. R. D. Jordan, J. S. Burkle, L. T. Brown, E. B. Scrom, J. W. Hargus, and J. H. Nichols (National Naval Medical Center, Bethesda, Md.). p.103-13 of STI/PUB/84(Vol.II).

Four men became contaminated with cesium-137 chloride due to leaks in a 100 C source. The source was believed to be completely leakproof, since the cesium chloride was contained in a welded stainless-steel capsule that was covered with an outer steel jacket of standard Oak Ridge design. Most of the contamination occurred while the men were cleaning the components of a pneumatic device used to move the source. The most heavily-contaminated individual placed his mouth over the end of a transport tube and attempted to blow some dust out of the tube. The other men handled various parts of the transport mechanism and wiped dust out of holes with their fingers. None of the men washed their hands before eating lunch. When radioactive contamination was discovered on the following day, immediate efforts were made to decontaminate the men. Arrangements for whole-body counts were also made and, on the fifth day following contamination, the men reported to the Radiation Exposure Evaluation Laboratory. The body burdens on the fifth day ranged from 35–970 nC of cesium-137. During the next five to six days the burdens dropped rapidly and on the eleventh day ranged from 28–780 nC. After the eleventh day the body burdens of cesium-137 changed much more slowly. Whole-body counts made between the 11th and 160th day yielded biological half lives of 76, 95, and 126 d for the three most heavily-contaminated individuals. During the period of rapid excretion all urine and feces were collected and counted. These counts indicated a considerable superficial contamination prior to the eleventh day since only a portion of the removed cesium-137 was found in the urine and stool specimens. The body burdens of the four men are compared with normals of the same size, build, age, and diet habits. A short discussion of normal burdens is included. A brief description of the counting system, data handling techniques, and calibration procedures is also included. (auth)

25900 QUANTITATIVE EVALUATION OF DOSE-RESPONSE RELATIONSHIPS IN HUMAN BEINGS WITH SKELETAL BURDENS OF RADIUM-226 AND RADIUM-228. C. J. Maletskos, A. G. Braun, M. M. Shanahan, and R. D. Evans (Massachusetts Inst. of Tech., Cambridge). p.225-52 of STI/PUB/84(Vol.II).

The procedure and preliminary results of studies on the relationship between biological response and internal radiation dose in persons with skeletal burdens of ^{226}Ra and ^{228}Ra are described. The biological responses consist of a variety of clinical results such as x-ray scores, tumors, fractures, urinalysis, hematology, blood chemistry, and protein electrophoresis. The internal radiation dose was calculated and expressed as the retained body burden in microcuries of minimum pure radium-226 equivalent (MPRE), cumulative Rads, and cumulative Rad-years. The first step in the analysis determined whether a relationship existed between a clinical parameter and the radiation dose. The determination was carried out by applying a contingency test, by means of which the actual data are compared with a postulated model of independence between the two variables. If no independence was found then some relationship was presumed to exist and a quantitative description of the dependence was obtained. Least-squares curve fitting procedures were used to derive the coefficients and the standard deviations of the coefficients of a power series. Such an expression provided an empirical quantitative description of the results along with a measure of their variability, was useful for impartial comparison with results from other laboratories, but implied no biophysical mechanism. The clinical results on these subjects were compared with results from control subjects with normal radium burdens, whether or not there was a dependence on radiation dose. Preliminary results indicate that the x-ray score shows the strongest and clearest correlation with internal radiation dose. There were definite indications of non-skeletal effects at higher burdens, particularly in lymphocyte count and sedimentation rate, which were similar to those obtained in dog experiments at Utah. Further analysis is indicated. No clinically significant signs or symptoms were observed at MPRE < 0.5 μC. In the region 10^{-3} to 10^{-1} μC MPRE the clinical data are in the normal range. (auth)

25901 RETENTION OF RADIONUCLIDES BY INFANTS. I. STUDY TECHNIQUES AND ERROR EVALUATION. C. P. Straub, B. Kahn, H. N. Wellman, N. C. Telles, and R. A. Seltzer (Robert A. Taft Sanitary Engineering Center, Cincinnati). p.345-62 of STI/PUB/84(Vol.II).

The retention of radionuclides and stable chemicals in infants aged 1 to 11 months was measured since 1960. Infants volunteered by staff members for study in their respective home environments were selected after consultation with the family pediatrician and a staff physician. The infants were fed commercially prepared prepackaged foods ad lib, in terms of quantity and kind. These foods, the air breathed, and the water used directly and in preparation of the formula constituted the normal intake of radionuclides and stable chemicals of interest. Aliquots of the food, water, diapers, and paper tissues used were analyzed.

Excreta were collected in disposable diapers, and separated into those containing urine or feces. Retention of the following radionuclides and stable elements was or will be determined: strontium-90, strontium-89, cesium-137, radium-226, calcium, strontium, phosphorus, and potassium. The study differed from previous ones in several ways. The radionuclides and stable elements were at normally encountered concentrations and in their normally encountered chemical forms. Air and water contaminated at environmental levels and commercially available food materials were the only sources of intake, since no radionuclides or stable chemicals were added to the diet. The infants studied were normal, healthy (not hospitalized) youngsters in their home environments. The major problems consisted of controlling and maintaining records of all of the food intake, collecting all of the excreta, obtaining an excreta sample large enough for accurate measurement of the radionuclide and stable components contained, and measuring radionuclide and stable component concentrations in the intake and excreta accurately enough that significant retention values could be computed. A case worker was utilized for control of intake and excreta information and an electronic computer for data processing. Intake values of the analyzed components were checked by comparing phantom meals with computed amounts based on aliquots. A special paper diaper with a low stable strontium concentration was developed and utilized. Calcium and phosphorus retention values were computed and are now available for 30 infants. Strontium-90 retention relative to calcium was found to be higher in infants than in adults. (auth)

25902 BODY BURDEN AND EXCRETION OF STRONTIUM FOLLOWING INGESTION. M. Fujita (Japan Atomic Energy Research Inst., Tokyo). p.385-99 of STI/PUB/84 (Vol.ID.

The retention and excretion of strontium-85 following a single ingestion in a normal man were measured up to about 200 d. Assuming the fraction of Sr passing from the GI tract to the blood is 0.25, total body retention (q) and urinary excretion (u) are best expressed as a sum of three exponentials such as % dose, % dose/d and total excretion. Using the formulas obtained, it is possible to evaluate the body burden on urinalysis if the time between exposure and analysis is known. When the time is not known, uranilysis must be performed several times at suitable intervals to determine the time. In the case of chronic exposure like the daily intake of strontium-90 by fall-out, was found that the formulas are also useful to estimate the body burden and excretion from the pattern of daily intake. In this study, for example, it was assumed that the level of daily intake increased linearly from 1956 (almost 0 pC/d) to 1960 (about 7 PC/d) for four years, but stopped increasing thereafter and kept the level (about 7 pC/d) till 1962 for two years. The calculated body burden (240 pC) and daily urinary excretion (1 pC/d) at a given time (August 1962) were in good agreement with those measured. The daily urinary excretion (U) at that time may be related to the body burden (Q) by a simple equation according to exponential function model as follows, $U = (2/3) \times (0.693/T_b) \times Q$ where T_b is a representative biological half life of the nuclide. In this case, it was concluded that a half life of about 100 d must be used instead of each value of the three components (1.8, 8, and 600 d) in the formulas given. The value of T_b changes according to the pattern and duration of exposure. For instance, if exposure has occurred at a constant level for two years, T_b of 73 d must be adopted. (auth)

Radiation Effects

25903 (AD-608877) AN EVALUATION OF THE HUMAN RETINAL BURN PROBLEM ARISING FROM ATOMIC DETONATIONS. W. R. Elswick and H. H. Mitchell (RAND Corp., Santa Monica, Calif.). Dec. 15, 1959. Project RAND. Contract AF49(638)-700. 49p. (RM-2500(RAND)). $2.00(CFSTI).

The general problem of retinal burns resulting from nuclear detonations within the atmosphere was investigated. The work in the field was reviewed and employed in this study in order to allow quantitative assessment of the danger of eye burn in any particular situation. Burns will occur when the radiant intensity reaches a value of around 0.6 to 2.0 cal/sq cm on the retina. Maximum distances for threshold burn based on 2 cal/sq cm from low altitude bursts can extend for as much as 25 miles (daytime) to 75 miles (nighttime) depending upon the visibility and the yield of the weapon. The problem is minimized for most situations because the fireball will not be in the field of vision for most people. For those for whom it is in the field of vision, the size of the image and its location on the retina, are important in determining actual damage to sight. (auth)

25904 (AECL-2240) MEASUREMENT OF THE DOSE ABSORBED IN VARIOUS ORGANS AS A FUNCTION OF THE EXTERNAL GAMMA RAY EXPOSURE. A. R. Jones (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1964. 29p. Dep.; $1.00(AECL).

An average man phantom, containing all bones of the head and trunk, was irradiated from in front, behind, and rotationally with gamma rays of various energies. The exposures at sites within and on the surface of the phantom were measured with lithium fluoride dosimeters. Also the exposures at the same points in space were similarly measured in the absence of a phantom. Among sites chosen were the gonads, representative points in the red bone marrow, and the usual film badge positions. From the measured ratio of the internal and external exposure the absorbed dose at important sites was computed as a function of external exposure for gamma rays of varying energy and direction. (auth)

25905 (NYO-2456-1) [TRANSPORT AND METABOLISM OF ISOTOPICALLY LABELED MATERIALS IN THE EYE]. (Columbia Univ., New York. Dept. of Ophthalmology). [1965]. Contract AT(30-1)-2456. 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Tritium-labeled thymidine was used as a tracer of DNA synthesis in the rabbit lens in vivo. After small mechanical injuries to the anterior surface of the lens a large number of epithelial cells surrounding the site of injury were shown to be stimulated and to undergo DNA synthesis and mitosis. This stimulation of DNA synthesis and mitosis moved in wave-like fashion slowly outward from the site of the injury starting about 12 hr after injury. X radiation at doses of 200, 500, or 1000 R inhibited the development of the reaction to injury. Data are included from studies of DNA synthesis and mitosis in isolated rabbit lens maintained in tissue culture. (C.H.)

25906 (ORINS-49(p.9-39)) MECHANISMS OF RADIATION INJURY. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.).

Progress is reported in studies of mechanisms involved in both acute and subacute radiation injury in man and laboratory animals. Emphasis was placed on those effects characterized by hematologic, biochemical, immunologic, and cytologenetic changes. Data are included on the incidence and type of infections in leukemia patients treated with whole-body irradiation; the hematologic response of leukemia patients and other individuals to various radiation doses; tracer studies of the effects of radiation on lipid metabolism in rats and dogs under various pathological and dietary conditions, including sarcomas. (C.H.)

25907 (ORINS-49(p.127-31)) NASA RETROSPECTIVE STUDY ON IRRADIATION EFFECTS. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.).

The case histories of 94 patients who received whole-body irradiation in the course of therapy or as the result of a criticality accident were encoded and processed to determine the incidence of anorexia, nausea, and vomiting associated with 5 dosage groups. Data were analyzed by computer as part of a study to predict man's reaction to the ambient radiations of space. The results appear to indicate that, if the chance of an astronaut in space receiving 10 rads radiation to the abdomen is less than 1 in 1000, the chance that radioinduced severe nausea and vomiting will occur is less than 1:100,000. (C.H.)

25908 (ORNL-P-81) THIRTY-DAY MORTALITY OF ACUTELY X-IRRADIATED "GERMFREE" ICR MICE. H. I. Walburg, Jr., E. I. Mynatt, and D. M. Robie (Oak Ridge National Lab., Tenn.). [1961]. Contract [W-7405-eng-26]. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Germfree and conventionally reared adult ICR mice were exposed to 600–1000 R whole-body x radiation. The $LD_{50/30}$ was 739.2 R for conventional mice and 899.2 for germfree mice. Both the $LD_{50/30}$ and the slope of the mortality curve of the germfree mice were significantly different from those of the conventional mice. The elevated $LD_{50/30}$ and extended mean survival time seen in germfree mice support the conclusion that the bacterial flora play a significant role in radiation disease. (auth)

25909 (ORNL-P-1211) THE IMMUNOGENETIC BASIS OF HYBRID RESISTANCE TO PARENTAL MARROW GRAFTS. Gustavo Cudkowicz (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 47p. (CONF-650314-1). Dep.(mn); $2.00(cy), 2(mn) CFSTI.

From Symposium on Isoantigens and Cell Internations, Philadelphia.

The growth of parental marrow grafts in the hematopoietic sites of X irradiated F_1 hybrids is deficient if the donor mice are homozygotes for the D region of the H-2^b allele and if the recipient mice are heterozygotes at the same locus. However, the extent to which F_1 heterozygotes resist the growth of parental marrow grafts depends also on other genetic determinants, presumably one or more modifier genes contributed by the genomes of the parental strains entering the F_1 crosses. Hybrid resistance develops relatively late in life, at about weaning age. It is moderately radiosensitive, but can be abrogated by multiple injections of viable parental strain spleen cells into adult hybrids over a period of three to four weeks. Forty-day-old hybrids injected during neonatal life with parental strain marrow cells fail to develop resistance. Hybrid resistance can be slightly enhanced by multiple injections into adult animals of viable parental strain marrow cells, but only in some hybrid strains. Hybrid resistance is transferred adoptively by F_1 marrow or spleen cells to genetically susceptible irradiated recipient mice. These findings are consistent with the interpretation that genetic interaction between alleles in or near the D region of the complex H-2 locus leads to suppression of one or more parental isoantigen. Such isoantigens are relevant for the fate of hematopoietic cell grafts, but not for the fate of normal skin grafts. (27 references.) (auth)

25910 (ORNL-TM-1038) CALCULATED TISSUE CURRENT-TO-DOSE CONVERSION FACTORS FOR NUCLEONS BELOW 400 Mev. C. D. Zerby and W. E. Kinney (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 81p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

To assist in the evaluation of the hazard associated with exposure to high-energy neutrons or protons, a series of Monte Carlo computer programs was used to calculate the energy deposition that results from high-energy incident nucleons as a function of depth in a slab of tissue. The programs included nonelastic and elastic interactions, as well as evaporation processes and nuclear recoils. A 30-cm-thick infinite slab of tissue was treated, and cases of normal and isotropic incidence of 400-, 300-, 200-, 100-, and 60-Mev protons and neutrons were computed. From these data current-to-dose conversion factors were extracted for the average-whole-body, the 5-cm-depth, the surface, and the maximum doses. A set of quality factors (QF's) was adopted for transforming rad dose to rem dose, but detailed energy-deposition data are also presented so that any preferred set of QF's can be used to obtain estimates of the rem dose. (auth)

25911 (TID-21727) IONIZING RADIATION STUDIES ON MICE. Final Report. Leo K. Bustad, Noel M. Gates, Frances C. Replogle, Alan Ross, and Loren D. Carlson (Washington Univ., Seattle. Dept. of Physiology and Biophysics). Dec. 30, 1964. Contract AT(45-1)-1094. 100p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The response of individually-caged male mice (C57B1 x 101) following 100, 200, and 365-day exposure to external gamma or internal beta irradiation was studied. The facility utilized for external irradiation was a 2 curie cobalt-60 source that allowed exposure at levels of 0.1 or 0.2 R/hr for 8 hours a day in the same room housing control animals. As a source of internal irradiation, phosphorus-32 was administered in the drinking water twice per week for 100 days. This resulted in a total body dose of about 0.7 rad/day as determined in vivo by whole body monitoring of the bremsstrahlung. The response of animals pre-irradiated for 100 or 200 days (and their controls) to challenging doses of 50 or 300 R x ray was evaluated by determining leucocyte counts and thymus, spleen, testes, and small intestinal weights at varying times after exposure. None of the parameters evaluated definitely distinguished the pre-irradiated from the control mice with the exception of a slight depression in the weight of the testes in the pre-irradiated animals. The mortality of the mice following a lethal challenge was also used as a measurement of the extent of residual damage, adaptation or over-compensation due to pre-irradiation. There appeared to be no over-all effect of pre-irradiation for a period of 200 days for a total accumulated dose of about 320 R. There was, however, a suggestion of a protection effect in animals pre-irradiated for 100 days (accumulated dose about 160 R) before the administration of an acute dose of 700 R x irradiation. In the latter group 13 of 21 pre-irradiated animals survived compared with only 7 of 21 control animals 10 months after acute x ray exposure. There were indications that the irradiation of mice for 200 days at levels of 0.8 R/day increased oxygen consumption and that irradiation for a period of a year increased food intake in some groups. Food consumption increased in both the control and irradiated animals with advancing age even though their body weights declined in old age. Growth rates were slightly higher for the mice irradiated and held for their lifetime than in their controls. Although unaffected by pre-irradiation, water consumption was depressed following exposure to acute doses of 700, 800, or 900 R and the degree of depression was a function of dose. The organ burdens, following oral administration of phosphorus-32 for 100 days, in decreasing order of concentration were bone, thymus, liver, spleen, kidney, muscle, testes, and brain. A tenfold difference in concentration between bone and brain was observed. Dermestoid beetles proved effective in cleaning skeletons of adhering tissue. The average life expectancy for each of the two subgroups exposed to 0.1 R/hr for 8 hours a day for one year was 857 and 870 compared with 879 and 966 for their controls, and for the two subgroups exposed to 0.2 R/hr for a similar period was 856 and 894 days compared with 922 and 918 days for their controls. The incidence of gross abnormalities was higher in the control subgroups than in the irradiated subgroups at 20 months. No significant increase in tumor incidence was observed in the groups irradiated for one year compared with their controls. Although the dose levels used in the groups exposed for one year resulted in consistent small differences in patterns of longevity and growth between the averages for the irradiated and control mice, the differences in most instances were small relative to normal experimental variation. (auth)

25912 (UCRL-8268) THE ACTION OF PENETRATING RADIATIONS ON YEAST CELLS. Cornelius A. Tobias, Robert K. Mortimer, Ralph L. Gunther, and Graeme P. Welch (California Univ., Berkeley. Donner Lab.). [195?]. Contract W-7405-eng-48. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Several features of the inhibition of cell division of yeast cells (Saccharomyces cerevisiae) are elucidated. The production by x rays of recessive lethals and of dominant lethals was shown, and these two seem to account for the most part for the inhibition of cell division by x rays in various ploidy cells. Genetic rearrangements in the diploid cell go on for several generations and result in lethals as well as in impaired and recovered cells. One mechanism involved in the rearrangements is x ray induced crossover. The frequency of crossover is a function of linkage, and the induction of reversion mutations by x rays shows great variations in rate of reversion as well as in oxygen sensi-

tivity. Steady state populations of cells can exist under high dose rates of continuous irradiation. (auth)

25913 THE INFLUENCE OF DETERMINED RANGES OF ULTRAVIOLET RAYS ON THE SEDIMENTATION RATE AND THE OSMOTIC RESISTANCE OF ERYTHROCYTES IN THE PERIPHERAL BLOOD OF THE WHITE MOUSE (MUS MUSCULUS L.). Henryk Lach (Jagiellonian Univ., Krakow). Acta Biol. Cracov. Ser. Zool., 6: 83-96(1963).

After irradiating mice with uv rays in the spectrum of 289-405 mμ with an energy intensity of 52,000 erg/sec cm², an increase in the erythrocyte sedimentation rate (ESR) in relation to control material was observed. The increase in ESR in the male mice amounted to 0.88 mm on the average and in that of females to 0.85 mm. The minimum osmotic resistance of erythrocytes in the 1st experimental group shifted by 0.04% NaCl and the max by 0.02% NaCl in relation to the control material. In mice of the 2nd experimental group which were exposed in the spectrum range of 254-405 mμ with an energy intensity of 63,400 erg/sec cm², a distinct acceleration in the ESR in relation to controls was observed. Sedimentation rates increased in the males by 1.87 mm on the average and by 1.17 mm in females in relation to the controls. The min osmotic resistance of cells in the males diminished by 0.08% NaCl, and by 0.06% NaCl in the females. The max resistance in the group of females and males shifted by 0.04% NaCl in relation to the controls. Thus the osmotic resistance of erythrocytes diminishes under the influence of uv rays. The greatest decrease of resistance was observed in mice exposed in the range of 254-405 mμ. The diminished osmotic resistance of erythrocytes under the influence of uv rays is explained in the following manner: uv rays cause an increase of permeability in the cell membrane and therefore alterations take place in Na and K concentration between the environment and the erythrocytes. The increase in the ESR in mice exposed to uv irradiation in the range of 289-405 and 254-405 mμ appear to be connected with the increase of the globulin fraction of serum and of fibrinogen, the fractions containing so-called agglomerins, postulated as taking part in the mechanism of erythrocytes sedimentation. (BBB)

25914 GAMMA RADIATION AND THE REPRODUCTIVE BEHAVIOR OF MALE RHODNIUS PROLIXUS. J. C. Gomez-Numez, A. Gross, and C. Machado (Instituto Venezolano de Investigaciones Cientificas, Caracas). Acta Cient. Venezolana, 15: 97-104(June 1964). (In Spanish)

In view of the fact that Rhodnius prolixus is the principal vector of Chagas disease, a serious disease in regions of Latin America, radiosterilization of the male insects was investigated since this technique has been used successfully in eradicating or eliminating other insect vectors of disease. The effects of 2500- to 40,000 R doses of ^{60}Co γ rays were compared with earlier results obtained with x rays on the male insects. Fertility was reduced to 74.4% of normal after 2500 R. Fertility decreased with higher doses until only 0.3% fertility resulted at 20,000 R. Males exposed to 40,000 R were completely sterile and unable to mate because of radiation damage. Spermatogenesis was more susceptible to radiation than the mature sperm, so that sterility increased with time and mating frequency through the replacement of old sperm cells by new ones. Irradiated males mated more frequently than untreated ones and, as mating stimulates oviposition, the quantity of eggs layed by the females enclosed with them also increased. This effect on mating frequency was greater at lower doses and disappeared with time in an inverse relation to the dose. Rhodnius tended to loose its motility proportionally to the radiation dose received, but increased motility, lasting about 9 weeks, was observed after 5000 R or less. The sequence between insect feeding and irradiation influenced the degree of induced sterility, less sterility being obtained when feeding preceded irradiation. Probably this was due to the known relation between feeding and spermatogenesis. Life span was also affected in proportion to the dose. Mean male longevity was reduced from a normal value of 116 days to 17 days after 40,000 R. In tests to evaluate the mating ability of irradiated males competing with normal ones, it was shown that 5000 R or less do not hinder the insect's mating ability, at least within a limited initial time period. For an equal degree of sterility, γ radiation shows certain advantages over x rays only when the dose does not exceed 7500 R; above this dose x rays cause less change to the male's reproductive behavior. Although 5000 R improved the male's mating capabilities, for at least 9 weeks after irradiation, it did not produce the desired sterility. This is only obtainable with doses above the limit where mating-inhibiting damage appears. It is concluded that the sterile male technique is not applicable to R. prolixus. (BBB)

25915 ELECTRORETINOGRAPHIC RESPONSES TO PARTIAL RETINAL STIMULATION BY X RAYS. B. Tengroth and B. Karlberg (Univ.of Gothenburg, Sweden). Acta Ophthalmol., 42: 514-16(1964).

The electroretinographic (ERG) response was demonstrated after stimulation of a part of the human retina with x rays. X radiation with its high energy, unlike visible radiation, is not scattered in the ocular tissues and therefore it seemed reasonable to believe that only neuronal interaction could be involved. In this investigation cataractous patients were used as a precaution, yet the doses used never exceeded a tenth of the minimum acceptable for the lens. The exposure time was constant, 0.2 sec, the voltage varied between 105 and 110 kv, and the milliamperage range was between 60 and 150. The patients were kept in absolute darkness for 30 min prior to the experiment and a light ERG was recorded both at the start and at the end of each experiment. Ten exposures were made with a radiation dose ranging between 2 and 8 R, measured at the top of the cornea. Preliminary data showed that the ERG response following diffuse x-ray stimulation, measured as the amplitude of the b potential, never exceeds 60% of the normal light ERG. When a collimator diaphragm was used, the response was reduced to less than 20% of the response after diffuse total stimulation. The reduction in energy was, however, about 45%. The patient experienced a sensation of light at each exposure followed by a short afterimage. The sensation appeared as a sharp-edged disc when the parallel beam was used. The reduction in amplitude of the b potential following stimulation with the parallel x-ray beam could be the result of a reduction in total energy received at the retina. However, the dose-response curve, using the amplitude of the b potential as the response, showed a straight line relation with the line running at a 45° angle to the ordinate in the dose range used. This suggests that an energy reduction of 45% should result in a similar reduction in the amplitude of the b potential. However, this was not the case; the response being reduced by more than 80%. This suggests that the reduction may be explained by a smaller retinal area being stimulated. (BBB)

25916 THE RADIATION RESISTANCE OF SUBSTRAINS FROM STREPTOCOCCUS FAECIUM SELECTED AFTER IRRADIATION OF TWO DIFFERENT STRAINS. Ebbe Ahrensburg Christensen and Ebbe Kjems (Statens Scruminstitut, Copenhagen). Acta Pathol. Microbiol. Scand., 63: 281-90(1965).

Following irradiation of two air-dried strains of Streptococcus faecium with doses between 1.2 and 3.5 MRad in the electron accelerator facility or ^{60}Co plant, a number of substrains were selected. Some of these substrains had a lower resistance to ionizing radiation than the mother strain, some had unchanged resistance, and some had a greater resistance than the strain from which they were isolated. The most resistant substrains had a resistance of the same order of magnitude as M. radiodurans. The number of viable units per irradiated test piece decreased during the days after the irradiation. This post-irradiation effect was not the same for the different substrains. The after-effect appeared to vary with the effectiveness of the packaging and the water-content of the micro-organisms. No correlation was demonstrated between the resistance to ionizing radiation and the other characteristics known in the case of the substrains isolated. (auth)

25917 LOCAL AND DISTANT ACTION OF IONIZING RADIATION ON RESTING CELLS IN THE LIVER. Tadeusz Rudnicki. Acta Physiol. Polon., 16: 19-23(1965). (In Polish)

Mitotic delay after irradiation of resting cells may be the result of either local or distant action of ionizing radiation. In this regard, no quantitative differences between local and distant action of radiation on resting cells were found. Abnormal mitoses may be the result exclusively of local irradiation of resting cells. (auth)

25918 THE EFFECT OF ULTRA-VIOLET RADIATION ON THE METACHROMATIC COMPONENT AND HISTAMINE RELEASE OF THE MAST CELLS IN THE MESENTERY OF THE RAT. Erkki J. Valtonen, Boris Koch, Martti Siimes, and Juhani Jaenne (Univ. of Helsinki). Acta Rheumatol. Scand., 10: 215-20(1964).

The effect of short-wavelength uv radiation on the mast cells in the mesentery of the rat was investigated. The purpose was to compare the metachromatic component of the mast cell granule to the histologically demonstrable histamine in the mast cells during the process of rupture and disappearance of the mast cells after a short irradiation stimulus. Microscopic examination of the preparations showed that the mast cells were already slightly altered at 22.5 min postirradiation, and in the later preparations they had further changed. The mast cells were scattered, swollen, and poorly stained, and there was a great difference between the irradiated and control preparations. The mast cells were not, however, as greatly disrupted as seen in other treatments. The intercellular substance in the irradiated preparations took the metachromatic stain with toluidine blue distinctly better than did that of the control preparations. This indicates the release of the metachromatic substance into the surroundings of the disrupted mast cells. It was observed that both heparin and histamine were released simultaneously and in the same proportion during the whole observation period. The results point to a firm complex between heparin and histamine. In addition, short-wavelength uv radiation is shown to be sufficiently strong stimulus to cause disruption of the mast cell without first causing the separate release of histamine. (BBB)

25919 EFFECT OF OXYGEN ON RADIATION RESISTANCE OF MICE. F. B. Benjamin (National Aeronautics and Space Administration, Washington, D. C.) and L. Peyser. Aerospace Med., 35: 1147-9(Dec. 1964).

The effect of maintenance in an oxygen atmosphere at low pressure and of physical exercise on resistance to ^{60}Co γ irradiated was studied. A specially constructed low pressure chamber was designed. Six-week-old mice were maintained in oxygen at 260 mm Hg in the chamber for two hr before exposure at a dose rate of 90 R/min to total doses of 750 to 900 R. After 750 R the 50% survival time for the oxygen-exposed animals was 10.52 days and for the controls 14.95, giving a ratio of 0.74. After 900 R the 50% survival time for the test group was 7.32 and for the controls 9.31 with a ratio of 0.79. The leukocyte and erythrocyte counts showed a marked depletion of white blood cells and a slight decrease of the red blood cells. There were no significant differences between the experimental and control group. Blood smears taken five days after exposure show anisocytosis of the test and of the control animals. Polychromatophilia which was common under normal conditions appears to be less pronounced after exposure to radiation. Due to the marked depletion of the white count only an impression of increased fragmentation of polymorphonucleocytes in the test animals could be obtained, and very few bilobed lymphocytes were seen. The only significant pathological finding was increased bleeding in the bone marrow of the oxygen-exposed animals. Increasing the metabolic rate of mice by means of exercise during exposure to radiation (1100 and 1200 R) decreased survival time. Results do not indicate whether this is due to increased intensity of radiation damage or due to change of onset of clinical effects. (BBB)

25920 HUMAN CHORIORETINAL BURNS FOLLOWING HIGH ALTITUDE NUCLEAR DETONATIONS. James F. Culver (Brooks Air Force Base, Tex.), Norris L. Newton, Robert Penner, and Robert W. Neidlinger. Aerospace Med., 35: 1217-20(Dec. 1964).

During thermonuclear detonations in Operation FISH BOWL in October 1962, chorioretinal burns were accidentally sustained by two test personnel stationed on Johnson Island. These occurred at night from a very high altitude (tens of kilometers), missile-delivered device, at a slant range distance of over 30 nautical miles. Animal experiments during this same detonation demonstrated chorioretinal burns at the most distant station over 100 miles away. Both subjects reported immediate visual disturbances but could not relate adequate information regarding the exact degree of immediate incapacitation experienced. The initial subjective symptoms involved a transient blinding (described as a white sheet of light) which cleared rather rapidly leaving a central glowing positive scotoma followed by a small central negative scotoma. Ophthalmoscopic examinations revealed generally similar lesions in both patients, with each patient suffering chorioretinal damage bilaterally. One subject had a chorioretinal lesion in each eye which appeared as a circular white spot about 0.35 mm in diameter in the foveal region. A circumscribed area of erythema surrounded the white spot and extended out to a diameter of 0.85 mm. The remainder of the fundus appeared to be normal. The other case revealed a lesion in each eye that was similar to that of the first subject except that the white areas were slightly larger, being about 0.50 mm in diameter. Both patients exhibited absolute scotomas in each eye on the initial central field examination. Case one had a circular scotoma of about 1.5 degrees with a tail-like superior extension, and the second a slightly larger central scotoma of about 2.5 degrees, but without a tail-like extension. The visual acuity recording depended on how the patients were asked to fixate. Case one could barely discern a 20/400 target by direct viewing at 24-hr postexposure examination. At 6 months the bilateral absolute scotomas measured about one degree in diameter and all other measurements were within normal limits in case one. The other subject was not as effective in his assigned duties, and his visual findings were somewhat more severe. His best vision at near and distance was 20/60 bilaterally six months later. The results show that case one was looking almost directly at the detonation when it occurred (or at a specular reflection of the detonation), then looked down quickly (the eye being in motion at the onset) and blinked. This could explain the appearance of the paracentral scotoma with the early tail-like extension. In case two, the fovea was destroyed, and more energy was absorbed, as the result of either a longer exposure time or observation during a different segment of the time history of the fireball and perhaps also due to difference in pigmentation of the fundus. These cases show that chorioretinal burns do not ordinarily result in complete blindness, and that incapacitation depends upon the exact location and size of the lesion. Although the macular areas in both patients are involved, the individuals are not visual cripples and can perform useful occupations. (BBB)

25921 OXYGEN UNDER PRESSURE AND THE OXIDATION-REDUCTION-PROCESS. H. Laborit and F. Brue (Hopital Boucicaut, Paris). Agressologie, 4: 469-80 (Sept.-Oct. 1963). (In French)

Some facts and new concepts are presented that confirm the relations existing between the toxicity of oxygen and that of ionizing radiations. Attempts were made to elucidate the role of free radicals and the formation of lipoperoxides during some general physiologic processes, such as aging. It is believed that the metabolic disorders provoked by oxidizing processes are mediated by variations in the permeability of the cell membranes and the intracellular organelles. The stability of the physico-chemical structures of these membranes is believed to be bound up with the reducing power of the cell. The stability of a low intracellular redox potential is indispensable for the maintenance of the K content of the cell, thus for the maintenance of the membrane potential. It is also necessary for the inhibition of the action of radioinduced free radicals and the

reduction of lipoperoxides. Antioxidants make it possible to maintain a low intracellular redox potential by supplying labile intracellular hydrogen atoms capable of receiving them. According to the best evidence, these structures are essentially NADP and glutathione. However, attention is drawn to the importance of the hexose-monophosphate shunt as a pathway that commands the intracellular maintenance of the H_2 molecule, for the protection of the organism against various oxidants. It ensures the reduction of NADP and glutathione. A new class of radio- and oxygenoprotectors is thus postulated, that is, all substances promoting entrance of glucose-6-phosphate into the hexose-monophosphate shunt. This group includes insulin, glucose, chlorpromazine, some phenothiazine derivatives, serotonin, and sodium 4-hydroxybutyrate. (TCO)

25922 EFFECT OF RADIOACTIVE FISSION PRODUCTS ON YIELDS AND GRAIN QUALITY OF CROPS. G. V. Il'ina, S. G. Rydkii, and N. N. Kuznetsova (Moscow State Univ.). Agrokhimiya, No. 5, 83-90(1964). (In Russian)

The effects of ^{90}Sr content on the yields of some agricultural plants in field experiments was studied for 4 successive years. The initial radioactivity was ~1 mC/m^2. Inhibitory effects were observed on the 2nd generation of the plants; their growth and development were inhibited and the crop yields of Panicum and Setaria italica decreased. The grain of the 1st generation revealed some radioactivity but that of the 2nd one did not. Substantial changes were not observed in the growth and development of plants after the second generation and in the crop yields and seed viability. (P.C.H.)

25923 SOME EFFECTS OF GAMMA IRRADIATION ON SEEDS AND RHIZOMES OF MUSA. G. Stotzky, E. A. Cox, R. D. Goos, R. C. Wornick, and A. M. Badger (United Fruit Co., Norwood, Mass.). Am. J. Bot., 51: 724-9(Aug. 1964).

The influence of γ irradiation on the seeds of Musa balbisiana and on rhizomes of the commercially important parthenocarpic variety Gros Michel was investigated. The purpose of these studies was to determine the radiation tolerance of these materials, to determine whether irradiation can be employed to enhance germination of seeds and rhizomes, and to evaluate irradiation as a means of eradicating microorganisms, primarily the pathogenic fungus, Fusarium oxysporum f. cubense, from seed material. Doses of 0.1 to 570 kr were tested. The tolerance seeds were found to be considerably greater than that of rhizomes; e.g., 11.8 krad reduced the germination of rhizomes 92% and of seeds about 15%. Intact seeds exposed to doses higher than 48 krad did not germinate in non-sterile soil, but, when scarified and cultured axenically after irradiation, seeds which received doses as high as 70 krad germinated. Embryos excised from seeds exposed to doses as high as 285 krad formed callus, indicating that not all metabolic processes were inhibited by these extremely high doses. There was considerable variation in radiation tolerance between seed lots which was not related to their age, moisture content, or pre-exposure viability. Germination of intact seeds appeared to be stimulated by doses of 3 or 9 krad. No lasting differences attributable to the level of irradiation were apparent in the development of seedlings derived from either intact or sacrified seeds nor of plantlets derived from excised embryos. Conversely, there was a significant reduction, proportional to irradiation dose, in the growth of plants developing from rhizomes, emphasizing the greater radiation sensitivity of the vegetative propagule. The radiation tolerance of seed-borne microorganisms was considerably higher than that of the plant materials, indicating that γ irradiation is not effective as a means of obtaining pathogen-free rhizomes or surface-sterilizing seeds of M. balbisiana. (BBB)

25924 COMPARISON OF PHILADELPHIA CHROMOSOME-POSITIVE AND -NEGATIVE PATIENTS WITH CHRONIC MYELOCYTIC LEUKEMIA. Stephen Krauss, Joseph E. Sokal, and Avery A. Sandberg (Roswell Park Memorial Inst., Buffalo). Ann. Internal Med., 61: 625-35 (Oct. 1964).

Clinical and cytogenetic studies were made of 28 patients with chronic myelocytic leukemia (CML), comprising 18 males and 10 females, ranging in age from 33 to 79 yr. Clinically, hematologically, and in therapeutic response, the Ph^1-patients appeared to differ from the Ph^{1+} group. Incidental to these findings a case of radiation-induced leukemia is documented. Earlier studies indicating a higher incidence of Ph^1-negative patients with typical CML were based on blood or marrow culture techniques now superseded by the more reliable direct marrow preparation. With this latter method, demonstration of the Ph^1 chromosome is unaffected by chemotherapy, radiation treatment, or the presence of the blastic phase of the disease. In this comparatively large series of patients with CML, lack of Ph^1 chromosome in direct marrow preparations was in marked contrast to the reported experience of others. The Ph^1 chromosome appears to represent a fundamental property of the malignant transformation in leukemia, indicative of an alteration in the myeloid stem cell or hematogone itself, since it is also believed to be present in normoblasts and megakaryocytes as well as in granulocytes (but not in lymphocytes). It is suggested that this relatively homogenous Ph^{1+} group represents a distinct clinical entity, probably reflecting a common etiology. The heterogeneity of the Ph^{1-} group, on the other hand, suggests multiple etiologic factors differing from each other as well as from that responsible for Ph^{1+} disease. One factor said to be implicated in Ph^{1-} CML is ionizing radiation. It has been previously proposed that if either acute or chronic myelocytic leukemia develops 4 to 7 yr after a significant exposure to therapeutic doses of radiation, the disease is very likely radiation-induced. On these grounds, the Edinburgh group so categorized one Ph^{1-} patient with CML who had undergone repeated spinal irradiation for ankylosing spondylitis. However, only blood cultures were analyzed at a time when the patient was in hematologic remission. Since the Ph^1 chromosome may not be demonstrable during remission with the blood culture technique alone, this case is equivocal. In the present group, only one case satisfied the criteria for radiation-induced leukemia. Leukopenia developed three yr after a therapeutic dose of radioactive gold. This 60-year-old female underwent a panhysterectomy for adenocarcinoma of the ovary. Postoperatively, 157 mC of ^{198}Au was instilled intraperitoneally. Three yr later, splenomegaly and a white cell count of 45,000/mm^3 were noted. Bone marrow examination revealed an increase in mature granulocytic elements, and was interpreted as CML. She was Ph^1-negative on repeated study of bone marrow preparations, supporting the hypothesis that at least one of the causes of Ph^{1-} CML is ionizing radiation. None of the other Ph^{1-} cases had a history of prior radiation exposure. One Ph^{1+} case also had had therapeutic radiation, but the 16-yr interval between exposure and onset of leukemia is too long to support an etiologic relation. (BBB)

25925 ACTION OF GAMMA RAYS ON CHOLINESTERASES AND ON THE EFFECTS OF SARIN. A. Pochet and J. Goffart (Centre d'Études Militaires, Armée Belge). Arch. Intern. Pharmacodyn., 144: 579-83(Aug. 1, 1963). (In French)

Sarin (isopropyl methylfluorphosphonate) is a neurotoxic compound which greatly inhibits cholinesterases. Gamma rays also diminish the activity of cholinesterases. Experiments were conducted to determine if γ rays augment the inhibitory effects of sarin on horse plasma and mouse brain cholinesterases or increase its toxicity. Four samples of horse plasma were tested: no irradiation, 10,000, 50,000, and 100,000 R doses of ^{60}Co γ radiation. The cholinesterase activity was expressed by the volume of 0.01N NaOH consumed in 20 min to maintain a constant pH. The volumes in all four samples varied from 9.35 to 9.41 ml, being within the range of experimental error. Thus, even intense irradiation did not modify cholinesterase activity in horse plasma. Cholinesterase activity in 20 homogenized mouse brains averaged 4.91 ± 0.07 ml 0.01 N NaOH consumed in 20 min. For the brains of mice exposed to 1500 R the average volume was 4.82 ± 0.05 ml, an insignificant difference. Twenty-five mice were injected with

⅔ LD_{50} of sarin, and 24 hr later the brains were homogenized. The average volume of NaOH was 3.26 ± 0.04 ml, an inhibition of 34%. An hour after injection of ⅔ LD_{50} of sarin, 25 mice were irradiated with 1500 R. NaOH volume averaged 2.96 ± 0.07 ml, an inhibition of 40%. One hour after irradiation with 1500 R, mice were injected with ⅔ LD_{50} of sarin, and 24 hr later the brains of the 20 survivors were homogenized. Cholinesterase activity corresponded to 2.55 ± 0.21 ml, an inhibition of 48%. Irradiation before or after an injection of ⅔ LD_{50} of sarin did not noticeably increase its acute toxicity. One LD_{50} of sarin was injected in 13 mice, seven of which had received 1500 R. Within an hr, two nonirradiated and three irradiated mice died. The other irradiated mice died 8 to 10 days later. Forty adult albino rats were injected with one LD_{50} of sarin one hr after half had been irradiated with 1360 R. Within an hr nine irradiated and ten nonirradiated died. The combination of sarin and irradiation greatly decreased cholinesterase activity by impeding the synthesis of new molecules and restricting the regeneration of the inactivated enzyme. (BBB)

25926 AGING IN HIROSHIMA ATOMIC BOMB SURVIVORS. Robert E. Anderson (Atomic Bomb Casualty Commission, Hiroshima). Arch. Pathol., 79: 1-6(Jan. 1965). (TID-21222)

The age marker hexosamine: collagen ratio in skin and aorta obtained from men autopsied at ABCC, Hiroshima, during the period 1962-1964 was used in a consideration of accelerated aging in atomic bomb survivors. The study included 14 proximally exposed individuals paired by age with an equal number of individuals who were not in Hiroshima at the time of the atomic explosion. In a statistically significant number of the pairs (11) tissue from the exposed member was found to have a smaller hexosamine: collagen ratio than the nonexposed member; this suggests the presence of accelerated aging among proximally exposed persons. However, other possible explanations for the experimental observations are offered; in view of these, and until a broader knowledge of aging is available, the results should be interpreted with caution. (P.C.H.)

25927 DIE FORDERNDE WIRKUNG KLEINER STRAHLENDOSEN AUF PFLANZEN. VORTRAGE UND DISKUSSIONEN ANLASSLICH EINES COLLOQUIUMS AN DER BAYERISCHEN LANDESANSTALT FUR BODENKULTUR, PFLANZENBAU UND PFLANZENSHUTZ IN MUNCHEN VOM 30-31 MAI 1963. (The Accelerating Effect of Small Radiation Doses on Plants. Lectures and Discussion on the Occasion of a Symposium of the Bayer Land Institute for Soil Culture, Plant Cultivation, and Plant Culture in Munich on May 30-31, 1963). H. Glubrecht and A. Suess. Bayer. Landwirtsch. Jahrb., 42: No. 1, 1-100(1965). (CONF-630502)

The nine contributions to a Conference at the Bavarian Agricultural Institut in Munich May 30 to May 31, 1963, are compiled. Individual abstracts were prepared for each. (J.S.R.)

For abstracts of individual papers see: 25928, 25929, 25930, 25931, 25932, 25933, 25934, 25935, and 25936.

25928 THE CONCEPT OF THE TEST REACTION IN THE BIOLOGICAL RADIATION EFFECT. H. Glubrecht (Institut fur Strahlenbiologie, Hanover). Bayer. Landwirtsch. Jahrb., 42: No. 1, 7-10(1965). (In German)

The reasons for the lack of definitive results in the many studies on the biological effects of radiation are summarized. The test reaction or biological effect is defined and its validity compared with previous concepts. (J.S.R.)

25929 THE ACCELERATING EFFECT OF SMALL RADIATION DOSES ON PLANTS. K. Kaindl and M. Rosner (Institut fur Biologie und Landwirtschaft des Reaktorzentrums, Seibersdorf, Austria). Bayer. Landwirtsch. Jahrb., 42: No. 1, 11-29(1965). (In German)

The experimental results obtained in the study of the effects on irradiation on plants are critically evaluated on the basis of a bibliographic review. (J.S.R.)

25930 THE PHYSIOLOGICAL PROBLEMS OF THE EFFECT OF SMALL DOSES OF IONIZING RADIATION ON PLANTS. W. Simonis (Universitat, Wurzburg, Ger.). Bayer. Landwirtsch. Jahrb., 42: No. 1, 30-41(1965). (In German)

The stimulating effects of ionizing radiation on physiological processes, especially at the cellular level, are summarized on the basis of a bibliographic review. Enzyme reactions and the functions of cell organella are considered. (J.S.R.)

25931 THE EFFECT OF SMALL RADIATION DOSES IN SEED GRAIN IRRADIATION. S. Suess (Bayerische Landesanstalt fur Bodenkultur, Pflanzenbau und Pflanzenschutz, Munich). Bayer. Landwirtsch. Jahrb., 42: No. 1, 42-60(1965). (In German)

The effects of radiation in the dose range from 1 to 200 R were studied on winter wheat, summer wheat, summer barley, potatoes, sugar beets, and maize. The emphasis was on the effect on germination and germination progress, radiation effects on the seedling development, and yield modifications initiated by seed grain irradiation. The results obtained were summarized in graphs and tables. (J.S.R.)

25932 RADIOSTIMULATION STUDIES ON POTATOES. Zoltan Menyhert and Andor Balint (Institut fur Genetik, Godollo, Hungary). Bayer. Landwirtsch. Jahrb., 42: No. 1, 61-2(1965). (In German)

Two varieties of potatoes were exposed to γ doses of 400, 600, and 800 R. The average yield was determined as a function of the dose. The results show that in the majority of cases a stimulating effect can be detected. A determination of the relation of vitamin C content and irradiation dose showed that the vitamin C content is increased correlatively with increasing dose. (J.S.R.)

25933 ELECTROPHYSIOLOGICAL POTENTIALS IN PLANT CELLS UNDER X IRRADIATION. H. Miltenburger, H. Esch, and O. Hug (Universitat, Munich). Bayer. Landwirtsch. Jahrb., 42: No. 1, 63-8(1965). (In German)

The electrical and mechanical behavior of Mimosa pudica L. during and after x irradiation shows that the nastic motions are connected with characteristic electrophysiological phenomena. Intracellular potential measurements on isolated internodular cells of water alga Nitella spec. showed significant modifications of the rest potential after irradiation with 40 kR. The patterns of the rest potential after irradiation in the light and in the dark were shown graphically. (J.S.R.)

25934 THE EFFECT OF X RADIATION ON THE SEED GROWTH AND MATERIAL MODIFICATIONS IN POTATO TUBERS. F. Heilinger (Institut fur Pflanzenbau und Saatguterzeugung der Forschungsanstalt fur Landwirtschaft, Brunswick). Bayer. Landwirtsch. Jahrb., 42: No. 1, 69-77 (1965). (In German)

The effects of x radiation on the germination of potatoes were studied as a function of two parameters: the dependence of the physiological state of the tubers at the time of irradiation and the conditions of cultivation after the irradiation. The results showed that the effects of low doses on germination metabolism and therefore on vegetation and yield depends on three different factors: the physiological state of the tuber, the external influences after irradiation, and the radiation intensity. (J.S.R.)

25935 INVESTIGATIONS ON THE PHOSPHATE METABOLISM IN IRRADIATION OF SEED GRAIN WITH SMALL RADIATION DOSES. H. Keppel (Isotopen-Laboratorium der Forschungsanstalt fur Landwirtschaft, Brunswick). Bayer. Landwirtsch. Jahrb., 42: No. 1, 78-82(1965). (In German)

Wheat seed grain irradiated with x-ray doses were germinated. The phosphorus compounds of the substrates were labeled with ^{32}P. After 14 days the ^{32}P activity in the harvested plants was determined. The results showed a stimulating effect of the phosphorus uptake with the optimum effect at 100 R. The effect of low radiation doses on the yields of potatoes and summer wheat was also determined. (J.S.R.)

25936 THE EFFECT OF SMALL MASSES OF INCORPORATED RADIONUCLIDES ON PLANTS. Ernst-G.

Niemann (Technische Hochschule, Hanover). Bayer. Landwirtsch. Jahrb., 42: No.1, 83-100(1965). (In German)

Pot cultures of Arabidopsis thaliana were irrigated with finely distributed ^{90}Sr in order to determine its radiobiological effects. The modifications observed in four generations and the morphological effects found were reported. In the first generation there was a slight decrease of the generation time. In the fourth generation there was a sharp increase of the time between budding and fruiting. (J.S.R.)

25937 OBSERVATIONS ON THE HISTOLOGICAL CHANGES OF THE HUMAN LARYNX AFTER COBALT TELETHERAPY. V. Mattioli, O. Fini-Storchi, and L. Lippi (Universita, Florence). Boll. Mal. Orecchio, Gola Naso, 81: 201-33(May-June 1963). (In Italian)

This study deals with histological changes observed in healthy tissue after telecobalt irradiation of four cancer patients after a total laryngectomy two months to one yr after the ^{60}Co therapy. The patients received a total local dose varying from 5750 R to 7590 R. (TCO)

25938 INVESTIGATIONS OF RADIOPROTECTORS AND CHEMICAL RADIOSENSITIZERS. III. THE ACTION OF ACETONE AND URETHANE ON THE SURVIVAL OF ANIMALS IRRADIATED IN TOTO. S. Neukomm and M. de Trey (Centre Anti-Cancereux Romand, Lausanne, Switzerland). Bull. Soc. Vaudoise Sci. Nat., 67: 479-87(1961). (In French)

To determine if physiological salt solution (0.9% NaCl) influences mice sensitivity to in toto irradiation, a group was injected with the solution from 15 min before to five min after exposure to 650 R of 200-kv x rays. Only a slight increase was noted in the time it took 50% of the mice to die. Results are expressed in the number of days required for 50% mortality. In a second series of tests 12.5 mg urethane in 0.25 ml H_2O was administered to groups of mice from one hr before to five min after irradiation with 650 R. The average time required for 50% mortality was 7.5 days. In the control group 50% died within 10.1 days. The greatest effect was noted in the groups injected two min before and five min after irradiation, with 50% mortality at 6.6 and 5.5 days, respectively. One third of the mice injected 60 min before irradiation were not sensitized. This was probably due to the rapid destruction of urethane in the organism. The results showed a significant radiosensitizing effect of urethane when administered 60 min before to five min after in toto irradiation. In another series of tests, acetone did not seem to have any significant radiosensitizing effect when injected into mice 15 min before to 30 min after exposure to 650 R. The average time for 50% mortality was 9.77 days. In the control group, 50% were dead within 9.8 days. It is possible the dose given was too small to provoke reaction. In general, male mice were more sensitive to irradiation than females. In the control groups males had 50% mortality in 8.2 days, while females averaged 10.2 days. The age of the mice (5.5 to 10.5 months) played no role in the sensitivity to irradiation. (BBB)

25939 EMERGENCE AND FERTILITY OF AEDES AEGYPTI (L.) REARED IN VARIOUS CONCENTRATIONS OF P^{32}. D. F. Riordan (Canada Dept. of Agriculture, Belleville, Ont.). Can. J. Zool., 43: 497-501(May 1965).

Aedes aegypti (L.) was reared in eight concentrations of ^{32}P from 0.05 to 0.8 μC/ml to test the effects on fertility of the adults. Up to 0.3 μC/ml little effect was seen in the numbers pupating, but at 0.2 μC/ml and higher many of the adults were so weakened as to be unable to leave the surface of the water. At 0.6 and 0.8 μC/ml no adults lived to become parents of a succeeding generation. No progeny were produced by females reared at 0.2 μC of ^{32}P per milliliter or by non-radioactive females mated to males reared at 0.3 μC of ^{32}P per milliliter. Amounts of ^{32}P in the adults of males and females were calculated. (auth)

25940 A CONTRIBUTION TO THE TREATMENT OF X-RAY ULCERS. K. Kratochvil (Steiermaerkische Gebietskrankenkasse, Graz). Chirurg, 33: 517-20(Nov. 1962). (In German)

Skin injuries that result from irradiation may appear anytime from 3 or 4 days to as long as several years after irradiation. At least 30% of these may develop into carcinomas if the patients survive long enough. Characteristics of these types of ulcers include incrustation and induration of the connective tissue, and an extensive vascular obliteration and sclerosis. Additional external injuries and secondary infections cause progressive tissue destruction. Although the ulcer may remain the same size, it is refractory to healing. Surgical intervention is usually necessary. After the ulcer and the damaged area surrounding it have been removed, the granulation area can be covered with Reverdin flaps. This should be accompanied by vitamin E treatment to bring about shrinkage of the collagen connective tissue. This is followed by proliferation of new capillaries, regeration of closed vessels, decrease of capillary permeability, and accelerated development of granulation tissue. Plastic surgery with Reverdin flaps may often produce more favorable results than displacement flaps. (BBB)

25941 THE STUDY OF GENE AND CHROMOSOME MUTATIONS IN HUMAN AND OTHER MAMMALIAN CELL CULTURES. Bentley Glass (Johns Hopkins Univ., Baltimore). Cold Spring Harbor Symp. Quant. Biol., 29: 177-83 (1964).

Results are summarized from a series of studies on techniques of animal cell culture, cytogenetic studies of normal chromosome number and karyotypes of the platyrrhine monkey, using cultures of kidney epithelial cells or bone marrow, studies of the effects of 25 and 50 R doses of x radiation on chromosomes of human and other primate cells grown in culture, efforts to find a genetic marker scorable in individual cells, efforts to find a genetic system in which cellular differences might serve as a basis for the detection of mutation in single cells or mutant clones, and studies of the effects of various radiomimetic agents on human chromosomes. (C.H.)

25942 VARIATION IN THE CONTENT OF NUCLEIC ACIDS IN THE TISSUES OF AXOLOTL EXTREMITIES FOLLOWING THEIR X-RAY TREATMENT AS AGAINST NORMAL REGENERATION. N. A. Teplits (Sebertsov Inst. of Animal Morphology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 159: 442-5(Nov. 11, 1964). (In Russian)

A total of 101 axolotl (larval salamanders) 10 months old and 12 to 15 cm long were given an x-ray dose of 8000 R on the extremities. The concentrations of RNA and DNA were determined on the 1, 3, 7, 10, 15, 20, 30, 45, 60 and 110th day a) after the irradiation and b) after irradiation with the same dose but treating the animal by injecting 125 μg of RNA into the muscle each day on 5 different occasions. In both cases the irradiated extremities were not amputated. The concentration of RNA decreased from a normal value of 185 μg/100 mg of dry tissue to 54 μg/100 mg on the third day after the irradiation for the irradiated tissue, and to 66 μg/100 mg for the irradiated tissue in the animal treated with RNA. The RNA values were 89 μg on the 5th day, 73 μg on the 7th day, 76 μg on the 10th day, 83 μg on the 15th day, 33 μg on the 20th day, 33 μg on the 30th day, 47 μg on the 45th day, 75 μg on the 60th day, and 77 μg per 100 mg on the 110th day after irradiation for the animals treated with RNA. The value for the animals not treated with RNA was somewhat lower. The behavior of DNA was similar to that of RNA. Control experiments on unirradiated animals whose extremities were amputated showed that the RNA content decreased up to the first 20 days, rose sharply with the beginning of tissue differentiation, and approached a normal value on the 60th day after the operation. It was concluded that x irradiation leads to sharp decreases in the contents of RNA and DNA in the irradiated tissues, while the recuperation from surgical shock leads to an increase in RNA and DNA in the tissue. (TTT)

25943 THE EFFECT PRODUCED BY IONIZING RADIATION ON THE PHOTOPERIODIC REACTION OF PERILLA PLANTS (PERILLA OCIMOIDES L.). V. N. Savin (Inst. of Agricultural Physics, All-Union Academy of Agri-

cultural Studies, USSR). Dokl. Akad. Nauk SSSR, 159: 676-9(Nov. 21, 1964). (In Russian)

Perilla plants having 4 to 5 pairs of leaves were given ^{60}Co gamma doses of 1, 3, 10, and 30 kR. The plants were then exposed to a 12-hour photoperiod. A dose of 1 kR led to budding and flowering of the irradiated plant 2 days earlier than the unirradiated control. A dose of 3 kR led to budding and flowering 4 days earlier than the control. A dose of 10 kR gave a plant with retarded development, while the plants irradiated with a 30 kR dose did not grow at all, even though they did not die. A dose of 3 kR led to suppression of growth processes. The height of the irradiated plant and the area and weight of a single leaf were less in the irradiated plant compared to the unirradiated control plant. The growth of side runners was stimulated by a dose of 3 kR, and consequently, the total seed yield of the plant was increased by about 40% compared to the unirradiated control. The amount of sugars and dry matter in the leaves increased in the irradiated plants (1 to 3 kR dose) as compared to the unirradiated plants. (TTT)

25944 ON THE NATURE OF THE PRIMARY RESPONSE TO LIGHT IN THE ONTOGENY OF RABBITS IRRADIATED AT DIFFERENT STAGES OF THEIR ANTENATAL DEVELOPMENT. M. S. Myslobodskii. Dokl. Akad. Nauk SSSR, 159: 690-2(Nov. 21, 1964. (In Russian)

The response to light was investigated in the progeny of unirradiated control rabbits and of irradiated animals that were given an x-ray dose of 400 R on the 15th and 23rd day of prenatal development. The bioelectric induced potential was taken from the exposed cortex of the head by means of an electrode fixed to a platinum loop. Energy pulses of 140×10^{-2} joules with a duration of 50 μsec were fed from a distance of 20 cm from the contra-lateral eye of the rabbit. The stability of the positive wave, which precedes the negative wave, was greatest in animals irradiated on the 15th day of embryogenesis, and the least during irradiation on the 23rd day of prenatal development. The amplitude of the primary response progressively increased in later stages of growth. The progeny of animals irradiated on the 15th day had responses of more mature animals than the progeny of animals irradiated on the 25th day of embryogenesis. (TTT)

25945 RADIOSENSITIVITY OF LYMPHOCYTES OF PERIPHERAL BLOOD IN VITRO IN ANIMALS BELONGING TO DIFFERENT GENOTYPES. N. I. Nuzhdin and N. N. Kuznetsova (Inst. of Genetics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 159: 923-5(Dec. 1, 1964). (In Russian)

Luminescence microscopy was used to study the radiosensitivity of lymphocytes from rabbits, man, rats, guinea pigs and mice. The blood sample was stabilized with 2% sodium citrate and glucose. Half the blood sample was subjected to an x-ray dose of 10,000 R, and the other half of the blood sample served as a control. Irradiated mouse blood was used as a standard of comparison in the cytological observations. A weighted damage factor K was assigned to each type of blood after cytological examination under the microscope. The damage to the lymphocytes can be arranged according to decreasing radiosensitivity as follows (the numerical value of the damage factor K is given in parenthesis): rabbit (3.13) > man (2.62) > rat (2.61) > mouse (2.40) > guinea pig (2.16). The damage to the blood of man, rats and mice cannot be distinguished. No differences in blood behavior were noted between the sexes. (TTT)

25946 THE RELATION BETWEEN THE RATE OF CHROMOSOMAL ABERRATIONS AND THE INTENSITY OF SEED IRRADIATION AND THEIR HUMIDITY. N. I. Nuzhdin and K. A. Filev (Inst. of Genetics and Central Genetics Lab., Sofia). Dokl. Akad. Nauk SSSR, 160: 224-6(Jan. 1, 1965). (In Russian)

Winter barley seeds (Bulgarian type 1294) having a moisture content of 6.4, 11.5, 27.6, and 51.3% of the dry weight were given a ^{60}Co gamma dose of 18 kR at dose rates of 264 and 17 R/min. The seeds were sprouted, and cells in the stage of late anaphase and early telophase of mitotic divisions were examined for chromosomal bridges and fragments. The results show that the yield of chromosomal aberrations is higher at the higher dose rate of 264 R/min than at a lower dose rate of 17 R/min at all moisture contents of the seed. The lowest percent of aberrations was observed in seeds with a moisture content of 11.5%. The percent of cells with bridges increases with increasing seed moisture on irradiating the seed at a dose rate of 17 R/min. On the other hand, the percentage of cells with fragments increases with increasing seed moisture on irradiating the seed at a higher dose rate of 264 R/min. Further study is needed to explain the reasons for these differences. (TTT)

25947 INFLUENCE OF γ-RAY RADIATION ON THE GERMINATION AND EARLY GROWTH OF PAPAVER SOMNIFERUM L. (PRELIMINARY REPORT). Toyohiko Kawatani, Sanaenosuke Fujita, and Tadano Ohno (National Inst. of Hygienic Science, Tokyo). Eisei Shikenjo Hokoku, 80: 163-3(Sept. 1962). (In Japanese)

P. somniferum seeds were soaked in distilled water overnight before being exposed to γ irradiation from a ^{60}Co source. Five groups of seeds receiving different irradiation doses (P_0 0 R, P_1 500 R, P_2 1000 R, P_3 5000 R, P_4 10,000 R), each consisting of 100 seeds, were prepared and planted in pots, each containing five seeds. These were kept in a greenhouse for about a month and then taken outdoors. The results showed that, compared to the control group (P_0), germination and survival rate of the seeds planted was significantly reduced in groups P_3 and P_4; in the last group only one seed survived. In all groups, however, the growth rate of surviving plants in terms of plant height and number of leaves showed no significant differences. It concluded that radiation doses of 500 and 1000 R have no significant effects on germination and growth of P. somniferum, while doses of 5000 or 10,000 R severely affect germination and growth. (BBB)

25948 INFLUENCE OF X-RAY RADIATION ON THE GERMINATION AND EARLY GROWTH OF ARTEMISIA KURRAMENSIS QAZILBASH. Toyohiko Kawatani and Tadaro Ohno (National Inst. of Hygienic Science, Tokyo). Eisei Shikenjo Hokoku, 80: 163-4(Sept. 1962). (In Japanese)

A. kurramensis seeds were soaked in distilled water overnight before being irradiated by ^{60}Co. Five groups of seeds receiving different radiation doses (A_0 0 R, A_1 500 R, A_2 1000 R, A_3 5000 R, A_4 10,000 R), each consisting of 200 seeds, were planted in wooden pots in a greenhouse. After about one and one-half months, these were transplanted outdoors. Their germination and survival rates, plant height, number of leaves and branches, and rate of budding and blooming were examined. It was found that the germination rate in all groups was similar and no significant differences attributable to irradiation were discernible. The growth rate in A_3 and A_4 groups was very low and all plants withered and died, but no significant differences in growth rate among A_0, A_1, and A_2 groups were found. The number of leaves, rate of budding and blooming were similar in these groups. With the radiation doses of 5000 R and over, no plants survived. At the doses of 500 and 1000 R the number of leaves and branches was somewhat decreased, but no significant influence was shown in other respects. (BBB)

25949 INFLUENCE OF γ-RAY RADIATION ON THE GERMINATION AND EARLY GROWTH OF ATROPA BELLADONNA L. Toyohiko Kawatani and Tadaro Ohno (National Inst. of Hygienic Science, Tokyo). Eisei Shikenjo Hokoku, 80: 165(Sept. 1962). (In Japanese)

A. belladonna seeds were soaked in distilled water overnight before being irradiated by ^{60}Co. Five sample groups receiving different irradiation doses (B_0 0 R, B_1 500 R, B_2 1000 R, B_3 5000 R, B_4 10,000 R), each consisting of 200 seeds, were planted in wooden boxes in a greenhouse. After about two months, they were transplanted outdoors. Examination of germination and survival rates, height of plants, number of leaves and branches, number of buds and fruit, weight of plant parts above ground and seeds was made. Germination of seeds in groups B_3 and B_4 was delayed for the first month, but after the first month no significant difference among the groups was

shown. There was no significant difference in budding rate among the groups. About one month after the transplantation, group B_4 showed a gradual decrease in survival rate. No clear differences among the groups in regard to plant height, number of leaves, branches, buds, and fruit, and plant and seed weight were discernible (possibly owing to many individual variations and soil conditions that could not be assumed to be uniform for all plants). With radiation doses of 5000 R and over, germination was delayed, and with the dose of 10,000 R, survival rate was lowered. (BBB)

25950 INFLUENCE OF γ-RAY RADIATION ON THE GERMINATION OF PAPAVER SOMNIFERUM L. Toyohiko Kawatani and Sanaenosuke Fujita (National Inst. of Hygienic Sciences, Tokyo). Eisei Shikensho Hokoku, No. 81, 147-50 (Oct. 1963). (In Japanese)

Seeds of P. somniferum were soaked for about 24 hr at room temperature prior to γ irradiation. The influence of irradiation on the germination percentage was tested. The doses were from 1250 to 320,000 R. Some germination was observed at all dose levels. Significant difference in the germination rate was not observed between those exposed to doses below 5000 R and the controls. Germination percentage was significantly low at doses above 10,000 R. The percentage germination at various doses was as follows: nonirradiated controls, 69%; 1250 R, 67%; 2500 R, 68%; 5000 R, 58%; 10,000 R, 20%; 20,000 R, 15%; 40,000 R, 12%; 80,000 R, 14%; 160,000 R, 9%; 320,000 R, 15%. (BBB)

25951 INFLUENCE OF γ-RAY RADIATION ON THE OPIUM PRODUCTION OF PAPAVER SOMNIFERUM L. PART I. Toyohiko Kawantani, Sanaenosuke Fujita, and Tadaro Ohno (National Inst. of Hygienic Sciences, Tokyo). Eisei Shikensho Hokoku, No. 81, 150-3(Oct. 1963). (In Japanese)

Seeds of P. somniferum were soaked for about 24 hr prior to γ irradiation. Influence of irradiation on the opium, morphine, and seed yields per capsule, morphine percentage, milky juice collection, and growth of the tops, especially the capsule, were observed. The doses were used 500, 1000, 1500, 2000, and 2500 R. With regard to the opium yield per capsule, the relation between the dose (A_1) and the opium yield (μ) was shown to be linear: $\mu = 208.04 - 0.0200\ (A_1 - 1250)$ mg. The morphine percentage of the seeds was not affected by the irradiation. The morphine yield per capsule showed a tendency to decrease with increase of the dose. The number of rays and size of capsules, and the plant height were not affected by the radiation. The milky juice collection showed a tendency to decrease at doses above 2000 R. The seed yield per capsule was higher after the dose of 1000 R than in the controls. A definite relation between the dose and the diameter and weight of capsules, and the weight of tops did not appear to exist. (BBB)

25952 INFLUENCE OF IONIZING RADIATION ON PROTEIN PRODUCTION BY HeLa CELLS IN CULTURE. G. Kellner, S. J. Frimmel, R. Krauze, and E. Broda (Universitat, Vienna). Experientia, 21: 190-1(1965).

The effects of radiation on the synthesis of (soluble and insoluble) proteins by HeLa human carcinoma cells in culture was studied by the radiochemical method. A tritiated water medium was used as the radiation source. The radiation dose was 29.2 Rad per day for 1 mC/10 ml. It was found that the cell count was significantly affected by irradiation at the level of 5 mC/10 ml. However, the incorporation of radioleucine, i.e. the synthesis of protein, was noticeably depressed only at the 50 mC/10 ml level. Because of the higher sensitivity to radiation of cell count compared with protein production, the average amount of protein synthesized per cell showed an increase with increasing dose. (P.C.H.)

25953 X-IRRADIATION-INDUCED POLYPLOIDY IN HUMAN LEUCOCYTE CULTURES. A. G. Bell and D. G. Baker (Hospital for Sick Children and the Banting and Best Dept. of Medical Research, Toronto). Exptl. Cell Res., 38: 144-52(Apr. 1965).

The effects of varying the time of x-radiation and the time of harvest on radioinduced polyploidy in human leucocyte cultures were investigated. When radiation was delivered early in culture (16 and 24 hr), very few endoreduplicated cells were produced (maximum 0.9 per cent), as compared with tetraploid cells (maximum 8.3 per cent). Irradiation at 48 hr resulted in fewer tetraploid cells (4.2 per cent), but more endoreduplicated cells (3.4 per cent). The initial high incidence of endoreduplication in this 48-hr culture fell to control levels 64 hr after irradiation, and remained low, whereas in this, and all other cultures, the tetraploid incidences remained high up to 96 hr after irradiation. In another experiment the effects of x-ray dose and duration of the colchicine treatment were explored. The higher dose (400 R) yielded a higher incidence of polyploidy than did the lower (250 R). The duration of the colchicine treatment had no effect on the endoreduplication-tetraploid ratio, although it did on the polyploid-diploid ratio; a much greater incidence of polyploids appeared in the cultures treated for the shortest time in colchicine. In this second experiment, endoreduplicated cells outnumbered tetraploids in all cultures, even 64 hr after irradiation. Polyploid induction results in either tetraploids or endoreduplicated cells. What determines the choice is not presently known. (auth)

25954 EFFECTS OF CHANGING ELECTROLYTIC CONTENT OF THE EXTERNAL MEDIA ON THE STATE OF REST POTENTIAL OF X-IRRADIATED STRIATED FIBROUS MUSCLES. V. M. Bogomolets (Bogomolets Inst. of Physiology, Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR, 10: 671-4(1964). (In Russian)

The potential at rest of the muscle tissue of M. sartorius frogs' legs, exposed to x radiation at a distance 7.5 cm at a dose rate of 3 kR/sec to a total dose of 162 kR was determined using a solution containing 116.25 mM of Na^+, 2 mM of K^+, 1.8 mM of Ca^{2+}, 117.1 mM of Cl^- and 2.95 mM HCO_3^- per liter of water. The K concentration of the solution varied up to a maximum value of 10 mM/liter. It was found that the K-free solution inhibited the potential at rest, as compared with the usual solution. Treatment of the irradiated muscles with solutions containing large amounts of K resulted in a stronger inhibition of the potential at rest. (TTT)

25955 STUDY ON THE PLASMA PROTEINS OF A-BOMB SURVIVED PATIENTS INCLUDING THOSE SUFFERED BY THE REMAINED RADIOACTIVITIES. REPORT 1. FROM THE VIEWPOINT OF THE WAVE PATTERN BY FILTER PAPER ELECTROPHORETIC TEST. Jun Makidono (Makidono Radiology Clinic, Japan), Shingo Takanashi, Tsutomu Yoshimoto, Takashi Kai, Mamoru Matsutani, and Motoi Miura. [Hiroshima Igaku,] 16: 799-805(Sept. 1963). (In Japanese)

25956 STUDY ON THE PLASMA PROTEINS OF A-BOMB SURVIVED PATIENTS INCLUDING THOSE SUFFERED BY THE REMAINED RADIOACTIVITIES. REPORT 2. QUANTITATIVE OBSERVATION OF THE PLASMA PROTEIN FRACTIONS BY ELECTROPHORETIC TEST AND TO SOLVE THE PROBLEMS FOR PHYSIOLOGICAL CLINICAL SIGNIFICANCE OF ITS PATTERNS. Jun Makidono (Makidono Radiology Clinic, Japan), Shingo Takanashi, Tsutomu Yoshimoto, Takashi Kai, Kiicihro Yoshimoto, Mamoru Matsutani, and Motoi Miura. [Hiroshima Igaku,] 16: 885-914 (Oct. 1963). (In Japanese)

The plasma proteins of A-bombed survivors, healthy persons, long term x-ray equipment handling people (for instance the radiologists and x-ray technicians), cancer patients, and tumor irradiated cancer patients were examined by the electrophoretic test. It was found that the electrophoretic patterns of plasma proteins could be divided into Normal (N-pattern) and abnormal (β and γ patterns) patterns, when they were classified according to the accents of each fraction. The patterns of the healthy persons and the long term x-ray handling people showed normal (N) pattern, however, it showed 43% abnormal patterns in A-bombed survivors and 48% in cancer patients. Furthermore, the patterns could be changed by radiotherapy to cancer, i.e., from N to β or vice versa. As a re-

sult of the quantitative observation about individual pattern, the accents of β-globulins in β-patterns and γ-globulins in γ-patterns were found. The globulins increased in the A-bomb survivors and the long term x-ray handling people, and this increase was also seen in the cases of cancer patients, which showed 85% of them were affected with ulcers (self disintegrated) by clinical examinations. A physiological clinical significance of these abnormal patterns (β and γ) in the plasma proteins indicates the disorders in its body and an important immunological meaning. Abnormal patterns in those who suffered by the remained radioactivities caused by the A-bomb showed 70%, whose average was much higher than those of direct A-bombed survivors. It is pointed out that, in recent days, there is a trend of more and gradual increase in the malignant neoplasms than the disorders of direct A-bombed survivors. (P.C.H.)

25957 EFFECTS OF CHRONIC LOW-DOSE IRRADIATION FOR THREE SUCCESSIVE GENERATIONS ON THE BREEDING BEHAVIOUR OF MICE. Susumu Muramatsu, Tsutomu Sugahara, Takehiko Tsuchiya, and Yoshiko Okazawa (Kyoto Univ.). Intern. J. Radiation Biol., 8: 523-31 (1964).

The effects of radiation on the reproductivity of mice were studied under the influence of chronic low-dose irradiation throughout reproductive period for three successive generations. The dose-rate used was 0.43 R/day, and the accumulated dose was 34.4 R for one generation. Mean litter-size increased with each generation in the irradiated series. Sterility and partial sterility were found in the later generations (P_2 and P_1 generations), but not in the earlier generations, and the increased incidence in the irradiated series was statistically significant. These may suggest that the radiation effects on reproductivity are, in part at least, cumulative at a very low dose-rate. From the incidence of sterility and partial sterility, the minor chromosome-aberration rate including translocation was calculated at $19.8-6.6 \times 10^{-4}$/R. (auth)

25958 PERMEABILITY OF CELLULAR MEMBRANES AND MODIFICATION OF CYTOPLASMIC CURRENT OF NITELLA FLEXILIS AFTER IRRADIATION. C. Gillet (Universite, Liege). Intern. J. Radiation Biol., 8: 533-9(1964). (In French)

Data were gathered immediately after irradiation by doses equal to or greater than 500 kR. There was a relation between the x-ray-induced changes in the rate of cytoplasmic streaming and those observed in the cellular permeability of Nitella. Immediately after a strong irradiation, the structural lesions of the cytoplasm were the most important. After a few hours permeability and cyclosis were correlated to a certain extent with ionic exchanges. These results confirm the early reactivity of membrane system to irradiation and show that after irradiation the plasmalemma is the most resistant membrane. (auth)

25959 THE FORMATION OF PEROXIDES IN TISSUE LIPIDS AND UNSATURATED FATTY ACIDS BY IRRADIATION. E. D. Wills and J. Rotblat (St. Bartholomew's Hospital, London). Intern. J. Radiation Biol., 8: 551-67 (1964).

Lipids extracted from rat liver, heart, brain, kidney and spleen have been shown to produce peroxides after irradiation with electrons. Peroxide formation was much greater in irradiated aqueous emulsions of lipids than in irradiated dry lipids, and it varied with the tissue used, a dose of 5 kilorads producing 5.0×10^{-8} moles peroxide/mg heart lipid but only 0.36×10^{-8} moles/mg spleen lipid. Dilute emulsions formed considerably more peroxide than concentrated emulsions, and the peroxide yield depended on the emulsifying agent used, its concentration and the pH. Peroxide formation per gram tissue is similar to yields found in irradiated animals, and it is considered possible that peroxide formation in vivo may be a result of direct oxidation of unsaturated lipids by oxidizing radicals formed in the aqueous phase. (auth)

25960 ANOMALOUS X-RAY SURVIVAL KINETICS IN HeLa CELL POPULATIONS. Robert A. Phillips and L. J. Tolmach (Washington Univ., St. Louis). Intern. J. Radiation Biol., 8: 569-88(1964).

Cultures of HeLa S3 cells which have grown for three days in a standard growth-medium containing human serum show a rapid drop in sensitivity to x-rays immediately after trypsinization. They subsequently undergo a further transient decrease in sensitivity lasting about one day, before slowly returning to the pre-trypsinization level of sensitivity about two days later. If grown in medium lacking human serum but otherwise identical to the usual medium, only the transient sensitivity change is observed. The latter is accompanied by changes in the rate of DNA-synthesis and in mitotic index, and appears to result from a partial synchronization of cell-growth brought about by the trypsinization procedure, with consequent redistribution of cells among the various sensitivity states that are characteristic of different periods of the cell-division cycle. The longer-term increase in sensitivity that occurs in medium containing human serum is correlated with alterations in the duration of the various phases of the cycle of DNA-synthesis. Hence it, too, would appear to arise from a redistribution of cells among the various interphase sensitivity states, although changes in the absolute sensitivity of one or more of these states may occur as well. No evidence was found for the occurrence of cell interactions that could lead to cooperative killing of sub-lethally damaged cells. (auth)

25961 RELATIONSHIP BETWEEN RADIATION-INDUCED MITOTIC DELAY AND DOUBLING-TIME OF CELLS. William C. Dewey, Ronald M. Humphrey, and B. Ann Jones (Univ. of Texas, Houston). Intern. J. Radiation Biol., 8: 605-7(1964).

In radiation experiments conducted with a mouse L-cell line and a Chinese hamster cell line, the mitotic delay for a given x-ray dose lengthened as the doubling-time of the cell-population increased. Mitotic delay was determined from the growth curve by noting the post-irradiation time interval required for the reappearance of cellular multiplication. To normalize for different radiation doses, the mitotic delay was expressed in terms of minutes per rad. Doses varying from 200 to 1000 rads were used. It is suggested that the increase in mitotic delay is associated with a decrease in the rate of some metabolic repair process in the cells that have a longer interdivisional time. (H.G.D.)

25962 GENETIC AND BREEDING IMPROVEMENT. Maria de Ranieri and M. Elisa Scarascia Venezian (Indagini all'Istituto di Frutticoltura, Rome). Ital. Agr., 101: Special No., 773-5(July 1964). (In Italian)

Genetic and breeding studies initiated on strawberries using cross-breeding and γ irradiation at 10,000 and 20,000 R are summarized. Some defoliation tests and testing of winter hardiness of the plants are also reported. (J.S.R.)

25963 MECHANISM OF RADIOSENSITIZATION OF MAMMALIAN CELLS BY EXPOSURE TO HALOGENATED PYRIMIDINES. Marvin A. Rich. J. Albert Einstein Med. Center, 2: 10-12(Jan. 1963). (NYO-3120-1)

The exposure of H.Ep. #1 cells, a line originally derived from a human cervical carcinoma, to 5-bromodeoxyuridine (BrUDR) in culture resulted in partial replacement of DNA thymine by 5-bromouracil. Cells exposed to BrUDR showed a 1.5 to 2.0 fold increase in radiosensitivity as compared to cells not exposed to the compound. The results also showed that radiosensitivity induced by BrUDR and the enhanced sensitivity observed when biological materials are irradiated in the presence of oxygen are probably unrelated. (P.C.H.)

25964 OCCUPATIONAL HAZARD. Murray L. Janower (Massachusetts General Hospital, Boston). J. Am. Med. Assoc., 190: 769-71(Nov. 23, 1964).

The case history of a patient developing a bone tumor ~ 40 yr after ingestion of Ra, while working as a luminous dial painter, is described. A histological diagnosis of osteogenic sarcoma was made, and a radical mastoidectomy was performed. Roentgenograms showed diffuse patchy areas of demineralization and sclerosis. Generalized bone changes were present, with multiple small lytic foci scattered throughout. The woman had a body burden of Ra of

0.19 μC or a Ra equivalent (i.e. including mesothorium) of 1.48 μC. The latent period was close to 40 yr. (TCO)

25965 ENVIRONMENTAL CAUSES OF CONGENITAL DEFECTS. Stewart A. Fish (Univ. of Arkansas, Little Rock). J. Arkansas Med. Soc., 61: 47-50(July 1964).

The role of the following factors on fetal injury and developmental defects is discussed: mechanical trauma, temperature changes, ionizing radiations, hypoxia, drugs, infections, and nutritional and hormonal imbalances. The magnitude of the problem of the congenitally malformed child is emphasized; an estimated 260,000 children were born in 1963 with some type of developmental defect. The causes of abnormal fetal development are basically either genetic or environmental. X irradiation can produce numerous developmental defects in the human embryo when administered during the period of organogenesis. Precautions for avoiding fetal radiation injury are presented. (H.G.D.)

25966 RADIATION INACTIVATION OF BIOLOGICAL AND IMMUNOLOGICAL ACTIVITIES OF BEEF THYROTROPIN. William D. Odell and William E. Paul (National Cancer Inst., Bethesda, Md.). J. Biol. Chem., 240: 2043-6 (May 1965).

Bovine thyrotropin was irradiated with 2.0 mev electrons. Biological activity of the bovine thyroid-stimulating hormone was measured by depletion of radioiodine from the thyroids of day-old chicks. Immunological activity was measured by a radioimmunoassay. Irradiation caused loss of activity as measured in each assay system, but the rate of inactivation was considerably less when measured immunologically than when measured biologically. The dose of radiation required to reduce biological activity to 36.8% was 22.5×10^6 rads (95% limits 19.8 to 26.1). The molecular weight calculated from these data is 32.0×10^3 (27.6 to 36.4), which is consistent with the molecular weight estimated by more conventional techniques. When immunological activity was measured with antisera A_2B, 36.2×10^6 rads (33.1 to 40.0) were required to reduce activity to 36.8%. The molecular weight calculated from these data is 19.9×10^3 (18.0×21.8). When immunological activity was measured with a second antisera (B_2B), 38.3×10^6 rads (31.5 to 48.9) were required to reduce activity to 36.8%, and the molecular weight estimated is 18.8×10^3 (14.7 to 22.9). These data indicate that an ionization occurring anywhere within the molecule is sufficient to destroy biological activity, whereas an ionization must occur in a considerably smaller volume to destroy immunological activity. An ionization occurring within the molecule, but outside this sensitive volume, will destroy biological activity but not effect immunological activity. (auth)

25967 LOCAL REDUCTION OF SPINDLE FIBER BIREFRINGENCE IN LIVING NEPHROTOMA SUTURALIS (LOEW) SPERMATOCYTES INDUCED BY ULTRAVIOLET MICROBEAM IRRADIATION. Arthur Forer (Dartmouth Medical School, Hanover, N. H.). J. Cell. Biol., 25: No. 1 Pt. 2, 95-117(Apr. 1965).

Irradiation of the mitotic spindle in living Nephrotoma suturalis (Loew) spermatocytes with an ultraviolet microbeam of controlled dose produced a localized area of reduced birefringence in the spindle fibers. The birefringence was reduced only at the site irradiated, and only on the spindle fibers irradiated. Areas of reduced birefringence, whether produced during metaphase or during anaphase, immediately began to move toward the pole in the direction of the chromosomal fiber, even though the associated chromosomes did not necessarily move poleward. Both the poleward and the chromosomal sides of the area of reduced birefringence on each chromosomal fiber moved poleward with about the same, constant, velocity. On the average, the areas of reduced birefringence moved poleward with about the same velocities as did the chromosomes during anaphase. The area of reduced birefringence was interpreted as a region in which most, though not necessarily all, of the previously oriented material was disoriented by the irradiation. The poleward movement of the areas of reduced birefringence indicates that the spindle fibers are not static, non-changeable structures. The poleward movement possibly represents the manner in which the birefringent spindle fibers normally become organized. All the experiments reported were on primary spermatocytes which completed the second meiotic division subsequent to the experimentation. Since both the irradiated and the control cells completed the two meiotic divisions, the movement and irradiation effects studied in the first divisions, the movement and irradiation effects studied in the first division were non-degenerative. (auth)

25968 LIMITING FACTORS INVOLVED IN CO_2 PRODUCTION BY STARVED AND X-IRRADIATED STARVED YEAST CELLS. Edward Spoerl, R. J. Doyle, and M. E. Thompson (Army Medical Research Lab., Fort Knox, Ky.). J. Cellular Comp. Physiol., 65: 271-6(Apr. 1965).

Studies of reduced CO_2 production by starved yeast cells were carried out to localize the site limiting this process and responsible for a greater production by irradiated cells. Cell-free extracts prepared before and after starvation of cells, and from irradiated and unirradiated cells, showed similar hexokinase activity and produced similar amounts of CO_2. These results demonstrated that rate limiting glycolytic enzymes did not decay during starvation, were not induced during a lag period in CO_2 production, which could be overcome by glucose incubation, and were not responsible for differences in CO_2 production between irradiated and unirradiated cells. Possible limiting factors involved in these differences include glucose transport as a consequence of differential decay during starvation, restricted cofactor synthesis, and an enzymic binding or compartmentalization. (auth)

25969 SOME EFFECTS OF GAMMA IRRADIATION ON THE GYPSY MOTH, PORTHETRIA DISPAR. P. A. Godwin, H. D. Rule, and W. E. Waters (Department of Agriculture, West Haven, Conn.). J. Econ. Entomol., 37: 986-90(Dec. 1964).

As a possible method for controlling this insect, the sterile male technique was investigated because the female gypsy moth does not fly, carries a potent sex attractant that insures mating, and mates but once. A procedure was developed for sterilizing male gypsy moths by γ irradiation with no impairment of mating efficiency. Male and female pupae of 3 age classes were treated: 1- to 3-days old, 4- to 6-days old, and 7 days and older. The dose rate of the source was 269,000 R/hr; 2500, 5000, 10,000, and 20,000 R doses were used. The degree of somatic damage was measured by pupal mortality and morphological abnormalities of adults. The commonest defect was the failure of hair and scales to develop. This injury ranged from the loss of a few scales, altering normal wing pattern, to complete absence of hair and scales except for a small tuft at the tip of the abdomen. The next most frequent injury was the failure of the pupal integument to disjoin from the adult. There was also a high incidence of failure of the wings to expand, the major defect among the insects treated as 4- to 6-day-old pupae. Females treated as pupae when younger than 7 days produced fewer eggs than females from older treated pupae. Eggs were more susceptible than sperms to irradiation damage as shown by lower embryogenesis and hatch of the F_1 progeny. Egg hatch was reduced in all age classes by 20,000 R, and in the 2 youngest age classes by 10,000 R, when males were treated. When females were treated, even the lowest dosage reduced egg hatch in all age classes. This study shows that males can be successfully sterilized by γ irradiation without crippling effects at certain dosages and ages of the insects treated. The irradiation of pupae more than 9 days old with 20,000 R reduced egg hatch to a sufficiently low level for control purposes and at the same time crippling defects were almost nil. In addition, irradiation had no apparent effect on the developmental rate of pupae or adults. The use of sterile male gypsy moths as a method of control seems feasible, but how successful treated males are in competing with normal males for mating in the field was not determined. (BBB)

25970 ELIMINATION RATE AND EFFECT ON REPRODUCTION OF INGESTED RADIOPHOSPHORUS IN THE BOLL WEEVIL. Norman Mitlin, Alan C. Bartlett, and

I. C. Keller (Dept. of Agriculture, State College, Miss.). J. Econ. Entomol., 58: 119-21(Feb. 1965).

Tests with radiation and chemosterilants demonstrated that the male boll weevil, Anthonomus grandis, requires high doses for permanent sterilization. With both types of treatment mortality was generally high and longevity and mating competitiveness were reduced. Experiments were designed to determine if feeding on radioactive material would cause the gonads of the boll weevil to retain sufficient amounts of ^{32}P to sterilize the insect or to cause detrimental mutations. Information was obtained also on the rate of elimination of ^{32}P; the amounts of radioactivity present after feeding, both in the entire insect and in the gonads; phenotypic changes, if any; the time taken for the ingested food to pass through the digestive tract; and the effect on weevils reared from the egg stage on radioactive medium. Radiophosphorus, as $^{32}PO_4$ (0.051 mC/ml), in weak hydrochloric acid was added to a solution containing 10% sucrose and a water extract of cotton squares. The biological half-life of ingested ^{32}P was 5.3 days in females and 7.3 days in males. Germ cells were relatively resistant to effects of the isotope. Ingested amounts up to 3.5 μC caused only a small decrease in fecundity, and when either the male or female was fed no effects on progeny or genetic changes could be detected. Sterile matings resulted only when both sexes were fed the isotope. There was no obvious chromosomal damage in the germ cells and no phenodeviants appeared in insects reared to the third filial generation. By feeding ^{32}P, sperm or seminal fluid or both could be labeled and traced to the spermatheca and ovaries of mated females. Larvae reared in a radioactive medium were inhibited in their development and only a small percentage developed to adulthood. These results show that in spite of relatively long exposure to high dosages of radioactive material emitting strong β rays, the boll weevil is resistant to the effects of radiation, and that feeding weevils radioisotopes to achieve sterility for subsequent release in the field would not be successful. (BBB)

25971 IMMUNIZATION OF MICE WITH IRRADIATED PASTEURELLA TULARENSIS. Milton Gordon, David M. Donaldson, and George G. Wright (Fort Detrick, Frederick, Md.). J. Infect. Diseases, 114: 435-40(Dec. 1964).

Experiments testing the antigenicity of Pasteurella tularensis rendered non-viable by exposure to ionizing radiation are described. The fully virulent SCHU S4 strain was used for challenge as well as vaccine preparation. A strain of reduced virulence (LVS) also was used in some studies. For irradiated vaccine preparation, the surface growth from a 24-hr agar culture was washed with 0.1% gelatin in physiological saline; the concentration of bacteria in the suspending fluid was about 10^{10} organisms per ml. β-Mercaptoethylamine hydrochloride (cysteamine) was added to the bacterial suspension at a final concentration of 0.02M prior to irradiation. An x-ray machine operating at 1 Mev was used to irradiate 2- or 4-ml bacterial suspension. The dose rate was from 8700 to 5150 R per min, and the total dose was 20 to 600 kR. The irradiated suspensions were diluted 1:10 in gelatin-saline, and injected into mice within 2 hr after irradiation. To minimize chemical alterations of antigenic components by free radicals, bacteria were irradiated in the presence of cysteamine. In the presence of 0.02M cysteamine, an irradiation dose of 10^6 R sterilized all bacterial suspensions, and the immunogenicity of irradiated bacteria was greater if cysteamine was present during irradiation. Higher concentrations of cysteamine appeared to be no more effective than 0.02M. To elucidate the interrelation among the dose of irradiation, cell viability, virulence, and antigenicity, several concentrations of attenuated LVS organisms and virulent SCHU S4 organisms were exposed to graded doses of x irradiation in the absence of cysteamine. As the concentration of bacteria was increased the dose of irradiation required for sterilization increased. This increased amount of irradiation required to kill bacteria as the cell concentration is increased is attributed to a decreased oxygen tension resulting from an imbalance between the endogenous respiration of the cells and the diffusion of oxygen into the suspension. Although less than 1 in 10^3 LVS organisms survived 20,000 R, the surviving organisms, even at 1:10 dilution, induced active immunity. Furthermore, irradiated SCHU S4 strain organisms killed mice when less than 1 in 10^8 organisms survived irradiation (300 kR or less). Thus immunogenicity and virulence of the surviving organisms were not appreciably altered by irradiation. Strain SCHU S4 rendered nonviable by exposure to 600 kR was shown to immunize mice as determined by increased resistance to intraperitoneal challenge. The mean survival time of the immunized animals was increased markedly as compared with controls, and a portion ranging from 5% to 50% in different experiments survived challenge. Injection of $\sim 10^8$ organisms was necessary to stimulate a minimal immune response. Evidently the immunity against challenge with fully virulent organisms evoked by the irradiated preparations is of a higher order than that produced by Foshay vaccine. The immunity is also greater than that evoked by the ether-extracted vaccine, but less effective than with viable vaccines. (BBB)

25972 ULTRASTRUCTURAL CHANGES IN STRATUM CORNEUM INDUCED BY ULTRAVIOLET LIGHT. Thomas E. Nix, Jr., Robert E. Nordquist, J. R. Scott, and Mark Allen Everett (Univ. of Oklahoma, Oklahoma City). J. Invest. Dermatol., 43: 301-7(Nov. 1964).

Stratum corneum thickening is observed as one of the features of the epidermal response to uv exposure. Since this thickening reflects altered keratinization, an investigation of events by electron microscopy was made to clarify the keratinization process. Four-times the minimal erythema dose of mercury vapor irradiation filtered through 2 cm of water was administered to the left lumbar area of a 24-yr old white man. Biopsy specimens were excised at intervals of 1, 3, 12, 72 hr, and 1 week. A thick parakeratotic zone formed beneath the normal stratum corneum (distal corneal zone) at 72 hr postirradiation. At one week after irradiation a third layer (proximal corneal zone) formed beneath the parakeratotic layer and is comparable in thickness to the distal corneal zone. The rapid formation of this proximal corneal zone implies accelerated epidermal renewal time. The parakeratotic zone shows several distinct differences from normal stratum corneum. Not only are nuclei retained, but the normal lamellar organization of horny layer is replaced by large spheroidal and less well-defined cells believed to be incompletely keratinized. The keratin pattern of the parakeratotic zone is different from normal, unirradiated stratum corneum, and from distal and proximal corneal zones. Although keratin filament diameter appears normal (70 Å) in the parakeratotic zone, the interfilamentous matrix is less dense than normal, implying that some alteration in synthesis of this matrix has been induced by uv light. Other alterations in parakeratotic postirradiated stratum corneum include the presence of oval lacunae (0.48 μ long), well-preserved melanin granules, and groups of dense particles (130 to 280 Å dia) thought to be ribosomes. A cell possessing a long dendrite-like process and melanin granules was observed in parakeratotic stratum corneum and may represent remnants of the melanocyte. In the postirradiated parakeratotic corneum the mechanism for keratin filament synthesis is apparently still intact. (BBB)

25973 CUTANEOUS NEOPLASM IN THE RAT PRODUCED BY GRENZ RAY AND 80-kv X-RAY. Herschel S. Zackheim, Elaine Krobock, and Lenore Langs (Wayne State Univ., Detroit). J. Invest. Dermatol., 43: 519-34(Dec. 1964).

This study describes development of basal and squamous cell carcinomas and fibrosarcomas in rats with single and repeated doses of low-voltage x rays (grenz ray) at 10-15 kv, and with harder x rays at 80 kv. In the grenz ray experiment, 83 rats 2 to 4 months old were used, including Fischer albinos, hooded rats of various shades, and solid black rats. No differential strain or sex response to radiation was noted. Treatments from 300 to 2400 R were given at 12.5 kv, and high doses (up to 9000 R) at 10, 12.5, and 15 kv. No tumors appeared before 180 days. There was a strong tendency for the rats which did develop neoplasms

to have several varieties of neoplasms. Consequently, while 16 rats had tumors, at least 27 different tumors were found. With single large doses 13 rats developed squamous cell and 9 developed basal cell carcinomas. With the repeated weekly treatments the reverse was true, 12 developed basal cell and 8 squamous cell neoplasms. Fibrosarcomas occurred in 7 rats receiving the large single dose, and none occurred in those receiving the weekly doses. The fractional dosage schedule was more effective than the single doses in producing neoplasms. Only 16 of 47 rats (35%) receiving 5000 to 9000 R in one dose and surviving over 6 months developed neoplasms. By contrast, 13 of 15 rats (87%) on the weekly schedule and surviving over 6 months developed tumors. The survival rate was high for both groups: 47 of 53 receiving single doses of 5000 R or over, and 15 of 18 receiving total weekly doses of 7800 R or over survived. Single and repeated doses of 80-kv x rays were less effective than grenz rays but exposed rats developed basal cell neoplasms, squamous cell carcinomas, and fibrosarcomas. With some schedules neoplasms developed in the absence of dermatitis or ulceration. No diffuse increase in acid mucopolysaccharide in the cutis accompanied the development of cutaneous neoplasms. Incidental findings included clear cell tumors, pigmented basal cell epitheliomas, and keratinizing sebaceous adenomas. The amount of radiation required to produce cutaneous neoplasms was greater with grenz ray than with 80-kv x ray. This was evident in the single dose schedules where effective grenz ray doses were not reached until 5000 R, although no treatments were given between 2400 and 5000 R. With 80-kv rays only 1000 R was required, and one basal cell epithelioma was produced by 500 R. These results emphasize the carcinogenic potential of both soft and medium-hard x rays. The greater dosage required to produce neoplasms with grenz as compared to 80-kv x rays confirms the general impression as to the relative safety of soft radiation, but should not obscure the hazards of its indiscriminate use. (BBB)

25974 THE EFFECT OF LOCAL X-IRRADIATION ON THE P^{32}-UPTAKE RATE OF RAT'S FEMUR. Kyo Soo Kim, Nam Soo Bin, and Ung Yun Ryo (Kyung Pook Univ., Taegu, Korea). J. Korean Med. Assoc., 7: 955-8(Oct. 20, 1964). (In Korean)

Local x irradiation of 900 γ was induced on one side of an albino rat's femur while the whole-body including the other side of the femur of the rat was carefully shielded and both femurs were removed at 3, 6, 12, and 24 hours after local x irradiation. Immediately after exposure, ^{32}P was administered intraperitoneally and ^{32}P-uptake rate was determined by measurement of the radioactivity on both the x irradiated and non-irradiated femur. The ^{32}P-uptake rate of femur in the control group increased very rapidly within a few hours and displayed peak level at 12 hours after administration of ^{32}P and thereafter decreased rather slowly until 24 hours. The ^{32}P-uptake rate of x irradiated femur was significantly lower than that of the control group. The ^{32}P-uptake rate of the non-irradiated femur in the x irradiated group showed higher values than the irradiated femur but significantly lower than the control group. There was some evidence of abscopal effect in non-irradiated femur of locally irradiated rats, comparing with the x irradiated femur. (P.C.H.)

25975 DEUTERIUM ISOTOPE EFFECTS IN NONENZYMATIC TRANSAMINATION OF L-GLUTAMIC ACID. Song-Ling Lin, Martin I. Blake, and Frederick P. Siegel (Univ. of Illinois, Chicago). J. Pharm. Sci., 54: 354-9 (Mar. 1965).

Culture of the algae Scenedesmus obliquus in a nutrient solution containing 99% D_2O provided a source of fully deuteriated amino acids. One of the more abundant amino acids present in the ionic fraction of the algae hydrolysate is L-deuterio-glutamic acid, which was isolated readily by gradient elution chromatography on a strong cationic exchange resin. The deuterio-amino acid was purified, and its identification was established by paper chromatography, elemental analysis, mp determination, NMR spectrum analysis, and determination of the specific rotation. In view of the important role of glutamic acid in enzymatic transamination, a study was made of the effect of D substitution on the rate of nonenzymatic transamination. The effects of pH and buffer concentration were also investigated. The nonenzymatic transamination of pyridoxal with protio-glutamic acid was first order in both reactants. The pH profile was established in the absence of added buffer. A broad peak appeared at about pH 4. The effect of 1:1 acetic acid-acetate buffer on the rate of transamination was observed up to a concentration of 1.0M. A sevenfold increase in the rate was noted when compared to the unbuffered system. The isotope effect was determined by comparing the velocity constants for protio- and deuterio-glutamic acids in buffered and unbuffered solutions. The protio-glutamic acid reacts about 2.1 times faster than the deuterio-glutamic acid. The rate controlling step appears to involve the abstraction of a proton or a deuteron from the α-carbon and a prototropic shift in the imine intermediate. The reaction appears to be general acid and general base catalyzed through a mechanism of the push-pull type. (BBB)

25976 EFFECTS OF RADIATIONS ON MITOSIS STUDIED BY TRADESCANTIA TEST IN VIVO. II. BETA-RAY IRRADIATION FROM A SOURCE OF STRONTIUM-90 AND CHROMOSOME BRIDGES FOUND IN CONTROL CELLS. Rungo Wada (Shizuoka Univ., Japan). J. Radiation Res. (Japan), 4: 91-6(June-Sept.-Dec. 1963).

The source of β rays was a thin ^{90}Sr plate (1 × 2 square cm and 1 mm thickness) wrapped with silver leaf, with a dose at the surface of 32.2 rad/min. This intensity was reduced further to 4 grades by absorption of glass plates of different thickness. One- and three-min irradiations were enough to induce chromosome bridges and yet showed no suppression for the occurrence of de novo mitosis in comparison with that in control cells. When the irradiation was continued for 15 to 20 min, the occurrence of de novo mitosis decreased to a few per cent of one-min irradiation. The number of chromosome bridges decreased with increasing thickness of the absorption filters. Description and microphotography of mitoses in Tradescantia cells observed in vivo have been recorded by the author since 1930. These records reveal that no chromosome bridges were found in the mitosis of Tradescantia hair cells before World War II. The first in vivo observations of the chromosome bridges in this material were made in 1942, under the effect of fast neutrons generated by a cyclotron on the mitosis of Tradescantia staminal hair cells. In 1942 no chromosome bridges were found in the control cells of Tradescantia cultivated in the garden of the Botanical Institute, University of Tokyo. However, at present, probably since the commencement of atomic bomb testing, Tradescantia cells with chromosome bridges have been found in the control material in the same garden. The number of chromosome bridges found in the control cells of this experiment indicates that radioactive fallout has already affected this plant material. In the case of x irradiations in small doses, sticky chromosome bridges were scarcely found in the Tradescantia test in vivo, while the same material irradiated with β rays shows usually sticky chromosome bridges together with dicentric ones. Thus the effect of x rays and β rays in small doses on mitotic cells differs with regard to the physiological effect on the chromosome in vivo. Judging from the results of this experiment and the descriptions of Tradescantia cells observed in vivo before the last World War, it is reiterated that the effect of radioactive fallout is considered to be already preserved as mitotic aberration in the meristematic tissues of living plants. (BBB)

25977 EXPERIMENTAL DATA ON X-RAY TREATMENT OF ACUTE PANCREATITIS. Gabor Jona and Mihaly Forgon (Orvostudomanyi Egyetem, Debrecen, Hungary). Magy. Radiol., 13: 100-5(1961). (In Hungarian)

Acute pancreatitis was induced in 8 dogs by injecting 5 ml of bile aspirated from the gall bladder, into several areas of the pancreas. Changes in the pancreas could be observed immediately, even before closing of the abdominal cavity. Blood samples were taken every 4 hr to determine changes in the blood amylase, lipase, and blood sugar. It

was found that the acute pancreatitis caused a significant rise in the blood sugar and amylase and lipase activities; however, 100-R local x irradiation caused a decrease in these values. Results were as follows: serum lipase activity (as ml 0.05N NaOH) in acute pancreatitis at 0 hr 0.48, 4 hr, 0.60, 8 hr 0.72, 12 hr 0.75, 16 hr 0.78, 20 hr 0.85, 24 hr 1.00, 48 hr 0.48; acute pancreatitis plus 100-R irradiation immediately after operation, 0.60, 0.50, 0.42, 0.50, 0.37, 0.36, 0.34, 0.51; control group of 5 healthy dogs receiving 100-R, 0.60, 0.52, 0.54, 0.29, 0.29, 0.40, 0.48, 0.62. Blood sugar values in mg% taken at the same time intervals for the three groups were as follows: experimental pancreatitis: 85, 85, 96, 106, 104, 114, 118, 111; pancreatitis plus x irradiation: 80, 70, 65, 71, 90, 95, 105, 108; control group receiving only x irradiation: 75, 62, 50, 52, 58, 52, 51, 75. Serum amylase values in mg % in pancreatitis were: 140, 210, 210, 230, 220, 200, 200, 185; pancreatitis plus x irradiation: 165, 170, 190, 185, 170, 165, 150, 175; control group with x irradiation only: 155, 140, 125, 100, 110, 140, 150, 155. Thus irradiation was effective in reducing the extent of these blood changes induced by pancreatic injury. (BBB)

25978 THE MEDICAL RESEARCH PROGRAM OF WHO PUBLIC HEALTH PRACTICE. VI. RADIATION HEALTH AND RADIATION MEDICINE. Med. Serv. J. (Can.), 21: 69-74(Jan. 1965).

Information is given on: general trends in research; collection of data on effects of ionizing radiation in man; and development of units, nomenclature, measurement, and methods. (P.C.H.)

25979 THE RELATION BETWEEN E. COLI B AND THE FILAMENT FORMING E. COLI K-12 MUTANTS. Howard I. Adler and Alice A. Hardigree (Oak Ridge National Lab., Tenn.). Microbial Genet. Bull., 21: 3-4(1964).

A nonmucoid filament forming mutant was isolated after exposure of E. coli K-12 AB1899 to irradiation. The new mutant is phenotypically almost indistinguishable from E. coli B. It suggests that E. coli B is an organism that contains a mutation leading to capsule formation and filament formation comparable to the E. coli K-12 mutants AB1899 and 3,300 M6 but which, in addition, has undergone a further genetic alteration that prevents the expression of capsule formation. (P.C.H.)

25980 VARIABILITY OF ANTAGONISTIC PROPERTIES OF STREPTOCOCCUS LACTIS UNDER THE EFFECT OF ULTRAVIOLET RAYS AND CERTAIN MUTAGENIC SUBSTANCES. V. I. Sudenko. Mikrobiol. Zh. Akad. Nauk Ukr. RSR, 26: No. 3, 37-43(1964). (In Russian)

The mutagenic effect of ultraviolet rays in doses of 360 ergs/mm^2 to 560 ergs/mm^2 and certain radiomimitic substances on the antagonistic activity of Streptococcus lactis in relation to Bact. dysenteriae Flexner were studied. With primary ultraviolet irradiation variants were obtained with an antagonistic activity higher than in the control. Repeated action of ultraviolet rays leads to the formation of a higher percentage of plus variants than the primary action. Dimethyl sulfate in a concentration of 1:1000 induces formation of a lesser percentage of positive variants than effective doses of ultraviolet radiation. The highest percentage of plus variants was obtained after the action of diethyl sulfate (1:200) on the active strain isolated from a suspension treated with dimethyl sulfate. Ethylenimine (1:5000) raised the percentage of only such active strains as were isolated from the control suspension as well. The maximum yield of plus variants and strains with a raised activity was observed with doses considerably lower than those which yielded the highest percentage of minus variants. (tr-auth)

25981 POST-RADIATION REDUCTION OF GENETIC DAMAGE IN MATURE DROSOPHILA SPERM BY NITROGEN. F. H. Sobels (Rijksuniversitet Leiden, Netherlands). Mutation Res., 1: 472-7(1964).

Earlier it was shown that postirradiation modification of x-ray damage is strongly influenced by conditions existing at the time of exposure. Thus, when Drosophila males are exposed to x irradiation under anoxia, and the effect of post-treatment with N_2 is compared to that with O_2, the frequency of recessive lethal mutations is reduced by N in sperm, but by O in spermatids and spermatocytes. After irradiation in O, however, post-irradiation modification was not observed in either stage of spermatogenesis. These findings were interpreted to mean that repair of premutational damage in sperm is favored by N, but in spermatids and spermatocytes by O, and that radiation in O_2 restricts the capacity to undergo repair. To verify whether the unexpected finding of postirradiation modification in mature sperm had been caused by shifts in the sampling of sperm cells with different radiosensitivities, the present experiments were repeated with mature sperm x irradiated in inseminated females. The results show that, after irradiation with 4000 R in anoxia, post-treatment with N consistently reduces the mutation frequency. This was observed for autosomal translocations. After irradiation with 2000 R in O, no post-treatment effect was found for lethals, but the frequency of translocations was significantly reduced by post-treatment with N. These results confirm the data already obtained from irradiated males. It is unlikely therefore that this effect in males had been caused by sampling of sperm cells with lower radiosensitivity in flies having received N post-treatment than in those which were post-treated with O_2. When the results for males and females are considered together, a highly significant decrease in sperm due to N post-treatment is observed. Altogether 18,451 chromosomes were tested for N post-treatment and 18,157 chromosomes for O post-treatment. The finding that no post-irradiation modification for recessive lethals is obtained after irradiation in O agrees entirely with the observations on irradiated males. As an interpretation, the possibility that the reduction of genetic damage after N post-treatment is caused by selective elimination of spermatozoa bearing mutations is unlikely. The postulation of a repair process which restores a proportion of the premutational damage after radiation in N, but not after irradiation in O is a more plausible explanation for these observations. The data suggest that there is only one process responsible for repair of both potential breaks and premutational damage. The finding, however, that after irradiation in O, post-treatment with N_2 lowers the frequency of translocations, but not that of lethals, raises the question whether two different processes are involved in repair of damage leading to mutations and chromosome breaks, or whether these different potential lesions react differently to the same repair system. (BBB)

25982 THE EFFECTS OF X-RAY IRRADIATION OF THE LIVER ON THE FUNCTION OF THE RETICULO-ENDOTHELIAL SYSTEM. Keisuke Ogawa (Nagoya City Univ., Japan). Nagoya Med. J., 9: 97-104(Dec. 1963).

X irradiation of the liver in rabbits conducted under optimal conditions was found to promote general immunity, with the irradiation dose and size of the irradiation field playing very important roles. The optimal size of the field was 5 × 5 cm and optimal dose 60 R at the skin surface. X irradiation of the liver undertaken percutaneously under the above conditions produced maximal enhancement of general immunity, and this state was maintained for the longest period. X irradiation of the liver helped to liberate the antibodies contained in the cells of the reticulo-endothelial system lying within the radiation beam into the blood stream and cause the primary rise in circulating antibody content. Morphological changes in liver tissue due to x irradiation of the liver are discussed. (P.C.H.)

25983 ERYTHROPOIESIS, A MODEL FOR THE STUDY OF FACTORS AFFECTING CELL PROLIFERATION IN THE MAMMAL. G. Hodgson and I. Eskuche (Universidad de Chile, Santiago). Natl. Cancer Inst. Monograph, 14: 169-84(May 1964).

These experiments were designed to study effects in mice of erythropoietin and γ irradiation on the erythropoietically competent stem cell population. Data are presented on the use of dose-response curves to erythropoietin in the assay of stem cell number and variations of affinity of stem cells for erythropoietin; the use of the

lethally and sublethally irradiated mouse to assay stem cells to obtain information on radiosensitivity, the protective effect of anoxia, and the influence on γ-ray-dose fractionation, and the influence of increased stem cell activity on radiosensitivity and the effect of high endogenous erythropoietin levels on recuperation after a single dose of irradiation. The state of erythropoiesis, as estimated by ^{59}Fe-uptake, was assumed to reflect changes in the erythropoietically competent stem cell pool. Advantages of erythropoiesis as a model system for the study of factors affecting cell proliferation are enumerated. The dose-response curve to erythropoietin in irradiated plethoric mice given injections of bone marrow is different from that of nonirradiated plethoric mice. The maximum effect depends on marrow dose, and the dose producing half max effect is six times greater than in nonirradiated recipients. Assays of radiosensitivity of erythropoietically competent stem cells were carried out by two methods: by ability of the irradiated cells to repopulate erythropoiesis in a lethally irradiated host, and by capacity of the animals' own surviving stem cells to repopulate. Fractionation of γ-ray dose had a marked effect on recovery of erythropoietic function after irradiation. Recovery was max when doses were separated by a 5-hr interval. Survival curves for erythropoietic function after γ-ray doses varied with the state of erythropoiesis at the moment of irradiation; the greater the level of erythropoiesis, the larger the shoulders on the curves. Recovery of erythropoietic function after irradiation in mice with high levels of endogenous erythropoietin showed a biphasic response, with an early abortive rise at day 6 and final recovery at day 18 at which time erythropoietic function was recovered in irradiated animals with low endogenous levels of erythropoietin. (BBB)

25984 PRODUCTION OF CLONES OF LYMPHOID CELL POPULATIONS. T. Mekori, L. Chieco-Bianci, and M. Feldman (Weizmann Inst. of Science, Rehovoth, Israel). Nature, 206: 367-8(Apr. 24, 1965).

Attempts to develop a method by which lymphoid clones could be produced are described. The methods included the in vivo cloning system for hematopoietic cells to lymphoid cell populations, and injection of hyper-immunized donor cells. The only system by which noduli (believed to represent clones of lymphoid cells) could be obtained repeatedly was that based on the introduction of lymphoid cells from lymph nodes or thymuses of donor that had been pretreated with M-phytohemagglutinin. Investigations were also made on the distribution of macroscopic lymphoid colonies within the irradiated spleen as a function of cell dose injected. It was concluded that the formation of lymphoid colonies seems compatible with the idea that a single injected cell could initiate a lymphoid colony. (P.C.H.)

25985 SIMILARITY OF REPAIR OF IONIZING AND ULTRA-VIOLET RADIATION DAMAGE IN MICROCOCCUS RADIODURANS. B. E. B. Moseley and H. Laser (Cambridge Univ., Eng.). Nature, 206: 373-5(Apr. 24, 1965).

The effects of mixed doses of gamma and uv radiations on the viability of M. radiodurans was investigated in order to determine whether a single repair system can repair both types of radiation damage or whether two separate, specific systems are involved. M. radiodurans was exposed to increasing doses of gamma radiation up to the dose required to cause exponential death. The cells were then exposed to uv radiation and their survival determined against uv dose. It was concluded that: preliminary gamma irradiation decreases the ability of the cells to repair uv damage; the uv repair system contributes to the repair of gamma ray damage; and the final lesion that renders the cell non-viable can be caused by either ionizing or uv radiation. The results support the view that the lethal effect of ionizing radiation is equally located in the nucleic acids. On reversing the sequence of irradiation by exposing first to uv followed by gamma radiation, a similar situation existed. (P.C.H.)

25986 A FATAL ANAEMIA IN SPLENECTOMIZED IRRADIATED MICE PROTECTED WITH ISOGENIC SPLEEN COLONY CELLS. John H. L. Playfair and Leonard J. Cole (Naval Radiological Defense Lab., San Francisco). Nature, 206: 419-20(Apr. 24, 1965).

Eight LAF_1 female mice 15 weeks old, of which 40 had been splenectomized 4 weeks earlier, were given 900 Rads of 250 kvp x rays. They were then injected intravenously with one of several cell-suspensions: 5×10^5 isogenic bone marrow cells; 1×10^5 isogenic bone marrow cells; 8.5×10^6 cells taken from the colonies in the spleens of 9 mice that had received, 13 days earlier, 900 Rads and 1×10^5 isogenic bone marrow cells; or the above nodule cell injection plus 10×10^6 isogenic lymph-node cells (nodule cells plus lymphocytes). Most groups showed the usual early mortality of post-irradiation marrow failure (8-12 days), and that this was less in the splenectomized animals. After 12 days there were no further deaths except in the splenectomized mice given nodule cells. The most outstanding deficiency was anemia of the splenectomized module-cell-protected mice. The addition of 10×10^6 lymph node cells, though it improved 30-day survival somewhat, did not relieve the anemia. Possible hypotheses to explain the results are suggested. (P.C.H.)

25987 THE EFFECTS OF IONIZING RADIATION ON THE SPONTANEOUS AND EVOKED BRAIN ELECTRICAL ACTIVITY IN RABBITS. I. THE EFFECTS OF X-RAYS ON THE HIPPOCAMPAL SPONTANEOUS ELECTRICAL ACTIVITY AND VISUAL CORTICAL RESPONSE TO PHOTIC STIMULUS. Takeru Minamisawa and Takehiko Tsuchiya (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 1040-8(Nov. 1964). (In Japanese)

The effects of x rays on the spontaneous and evoked brain electrical activity were studied in two groups of rabbits, each of which received 1,000 R of radiation either on the whole body (W-group) or on the head (H-group). Two kinds of spontaneous electrical activity, arousal and sleepy patterns, were observed before irradiation. In W-group after irradiation the appearance rate of the arousal pattern showed an immediate increase followed by a sharp decline. In several hours the rate began to increase gradually. The rise continued up to 20 hr when it reached a level higher than that in controls. At 24 hr there appeared a tendency to return to the control level. In H-group irradiation did not bring about an increase in the appearance rate until about 10 hr, after which the rate increased gradually to reach a level higher than those in W-group or controls at 24 hr. In controls the evoked potential caused by photic stimulus presented a small rapid wave followed by a large slow one. In W-group the potential of the large wave gradually became lower and lower until at 8 hr it reached the minimum level, from which it returned to the control level at about 24 hr after irradiation. In the case of H-group the minimum level of the potential appeared at 4 hr with a similar tendency of returning to the control level at 24 hr. (auth)

25988 ABOUT THE HIGH FLUX THERMAL NEUTRON IRRADIATION SPACES FOR SMALL ANIMALS IN JAPAN. Hiroshi Yasukochi and Noritoshi Watanabe (Tokyo Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 1055-66(Dec. 1964). (In Japanese)

Thermal neutron exposure spaces for research using small animals such as mice, rats, and rabbits are discussed mainly with regard to wideness of the spaces and data on thermal neutrons, fast neutrons and gamma rays. For this purpose the cyclotron of Tokyo University (in Tanashi) and the reactor of Japan Atomic Energy Research Institute (JRR-1 in Tokai) and of Tokyo Atomic Industrial Company (HTR in Kawasaki) were chosen, and some experiments were performed using these apparatuses. In convenience, No. 7 hole of JRR-1 is superior because the exposure case is easily handled while the reactor is working and this space is only one space designed for exposure of animals, but the space is too small, the flux distribution is too ununiform, and the flux is too unstable for such experiments. In the cases of the HTR reactor and the cyclotron, these apparatuses are designed without considering biological or medical experiments and the spaces for irradiation are constructed of paraffin and lead. Conse-

quently the spaces are wide enough for the experiment but it is impossible to change the cage while the apparatuses are working. The dimensional uniformity of thermal neutrons is best in the case of HTR. Because these apparatuses are mainly designed for technological purposes, a medical reactor or accelerator is expected to be built in the near future. (auth)

25989 HISTOLOGICAL STUDY ON PREOPERATIVELY IRRADIATED GASTRIC CANCERS. Tadayoshi Matsuda and Hiroshi Ushijima (Toyohashi City Hospital, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 1078-86(Dec. 1964). (In Japanese)

Histological investigations were carried out on 80 cases of preoperatively irradiated gastric cancers since Jan. 1960 in order to judge the effect of radiation. Sixty-two cases were irradiated with ^{60}Co γ rays, and 18 cases with 18-Mev betatron-electrons. The majority of the cases were given 4000 R during a 21 ~ 25 day period and operated 2 weeks after completion of irradiation. A marked effect was seen in 25%, moderate effect in 27.5%, and slight or no effect in 36.5% of the cases. There were differences in the effectiveness of irradiation depending on the types of histological classification. More effect was seen in carcinoma solidum simplex and adenocarcinoma tubulare and less in adenocarcinoma papillare. There was also evidence that the more atypical the histological pattern of the tumors the greater the effect of radiation. The radiation effect was less in the metastasized lymphnodes than in the primary tumors. The radiation effect was generally more marked with betatron electrons than with ^{60}Co γ rays. Histological investigation was also made on uninvolved portions of stomach, liver, spleen, and lymphnodes within the fields of irradiation. Frequent findings were edema and degeneration of collagen in the gastric submucosa, edema and atrophy of the muscular layer, reduction of white pulp in the spleen, and marked reduction in lymphocytes and germinal centers in the lymphnodes. (auth)

25990 RADIATION INDUCED SHORTENING OF LIFE OF SARCOPHAGA PEREGRINA AND ITS MODIFICATION BY DOSE FRACTIONATION. Masatashi Sakka (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 1185-8(Feb. 1965). (In Japanese)

Life shortening of adult Sarcophaga was one of the major late effects of radiation delivered at pupal stage. The effects were proportional to the dose with a threshold of several hundred Roentgens. With fractionated dose the effects were reduced suggesting that late effects such as life shortening is associated with acute ones. (NSA of Japan)

25991 TREATMENT OF CHRONIC MYELOID LEUKEMIA BY LOCALIZED IRRADIATION OF THE SPLEEN. EXPERIMENTAL STUDY OF THE RADIOLOGICAL EFFECT OF DISTANCE. Pierre A. Maurice (Policlinique Universitaire de Medecine, Geneva). Oncologia, 16: 208-9 (1963). (In French)

In order to confirm the hypothesis of a secondary bone marrow inhibition caused by splenic irradiation the authors selectively irradiated the exteriorized spleen of the rabbit. The changes in hematopoiesis were studied in the blood and bone marrow. A rapid, definite, and reversible inhibition of erythropoiesis in the rabbit was observed after a splenic irradiation of 300 R. This inhibition was manifested by a transitory fall in circulating reticulocytes and a diminution of medullary mitotic activity. A second group of animals that had been splenectomized previously were similarly irradiated in the exteriorized perisplenic region. The absence of any detectable modification of hematopoiesis in these animals indicated that the bone marrow depression observed after irradiation of the spleen is probably the result of an effect on that organ, and not the result of direct radiological injury of the bone marrow. In a third group of animals that were splenectomized after splenic irradiation of 300 R there was no depression of marrow activity, if the organ was removed less than 2 hr after the irradiation. On the other hand, when splenectomy was delayed beyond this time period it was not possible to prevent the antimitotic effect exerted on the bone marrow by the irradiated spleen. (BBB)

25992 STUDIES OF CHLOROPLAST PIGMENTS AND ASSIMILATION STARCHES OF CHLOROPHYLL B-FREE MUTANTS OF PISUM SATIVUM INDUCED BY X IRRADIATION. Franz Mueller (Universitat, Bonn). Planta, 63: 65-82(1964). (In German)

The concentrations of plastid pigments in four fertile chlorophyll mutants of Pisum sativum induced by x irradiation were measured spectrophotometrically and chromatographically. In comparison to the normal forms the concentrations of chlorophyll were from 40 to 50% of normal, and the amounts of carotenoids were from 70 to 100% of normal. Chlorophyll b was not detected in any of the mutants. In all four genotypes the carotenoid distribution was qualitatively equal or similar to the unmutated form. The concentration and formation of starch was studied in one of the mutants. Tests on the leaves showed that there was no starch formation before or after application of glucose. Iodide tests on leaf sections showed that starch was present only in the chloroplasts of the guard cells of the stomata, but the chloroplasts of the mesophylls were starch free. After glucose application starch formation was markedly increased in the guard cell chloroplasts, but not in the mesophyllic chloroplasts. These anomalies in the starch system indicate that these mutants should be grouped with the extreme saccharophilic plants. 65 references. (BBB)

25993 CHROMATOGRAPHIC PIGMENT STUDIES WITH CHLOROPHYLL MUTANTS OF PISUM SATIVUM INDUCED BY X RAY. Franz Mueller (Universitat, Bonn). Planta, 63: 301-15(1964). (In German)

Chromatographic analyses and studies of total pigment spectra in lethal chlorophyll mutants of Pisum sativum induced by x ray showed that all of the mutants contained qualitatively the same carotenoids as the normal form, with the exception of zeaxanthine. Each genotype was characterized mainly by a different, high, and genetically determined pigment concentration. The main carotenoids found were lutein, violaxanthine, and β carotene. Neoxanthine, flavoxanthine, and lutein-5,6-epoxyde were found with zeaxanthine in smaller amounts. These pigments are not usually found in green mutants and in the normal form. All of the carotenoid pigments studied in the mutants and in the normal form were identified by their absorption spectra, R_f values, starch zone electrophoresis, and color reactions with concentrated acids. The spectra of the total pigments showed a close agreement between each of the mutants, if the lack of chlorophyll containing several xantha forms is taken into account. This similarity of the curves indicates that the mutants differed from the normal form only in the amounts of pigments, but not in the types present. (BBB)

25994 ATOMIC ENERGY AND BREEDING. N. P. Dubinin (Inst. of Biological Physics, Moscow). Priroda, No. 3, 25-31(Mar. 1965). (In Russian)

A brief review is given of experiments with radioinduced mutations and remote hybridization of grain, cotton, beans, potatoes, and other vegetables. It is shown that nuclear energy and selectivity may improve the yield and quality of the harvest and animal breeding. (R.V.J.)

25995 GAMMA RAYS AND SOIL FERTILITY. A. M. Kuzin. Priroda, No. 4, 25-31(Apr. 1965). (In Russian)

A review is given on the uses and effects of ionizing radiation in agriculture. Radioinduced mutations, plant growth stimulation, ionizing radiation in animal husbandry and poultry farming are discussed. (R.V.J.)

25996 RENAL FUNCTIONS IN ACUTE RADIATION SICKNESS. Karel Zaruba (Charles Univ., Hradec Kralove, Czechoslovakia). Radiation Res., 25: 1-8(May 1965).

No serious disorder of the renal function that could induce renal insufficiency was observed in acute radiation sickness or even in the course of fatal radiation sickness in dogs. An observed decrease in Tm_{PAH} is suggestive of a certain decrease in the function of the tubuli. Changes in

GFR, RPF, and FF were believed due to changes in renal hemodynamics after irradiation. (auth)

25997 THE INTESTINAL MUCOSA OF GERMFREE MICE AFTER WHOLE-BODY X-IRRADIATION WITH 3 KILOROENTGENS. Taiju Matsuzawa and Raphael Wilson (Univ. of Notre Dame, Ind.). Radiation Res., 25: 15-24 (May 1965).

Germfree CFW mice exposed to 3 kR of whole-body x irradiation had a mean survival time of 7.3 days, whereas conventional CFW mice under the same conditions had a mean survival time of 3.5 days. The increased survival time in germfree mice is ascribed to the longer life span of mucosal cells. The migration of epithelial cells from crypt to villus tip took 4.3 days in germfree mice and 2.1 days in conventional mice. After 3 kR, the intestine was denuded in 3.5 days in conventional mice and not until 7 days in germfree mice. Death occurred very soon after denudation in both groups. (auth)

25998 STUDIES OF THE MORTALITY OF A-BOMB SURVIVORS. 3. DESCRIPTION OF THE SAMPLE AND MORTALITY, 1950-1960. Seymour Jablon, Morihiro Ishida, and Mitsuru Yamasaki (National Inst. of Health and Atomic Bomb Casualty Commission, Japan). Radiation Res., 25: 25-52 (May 1965). (TID-21263)

A sample of 99,393 persons for the Life-Span Study was completed, and each member was traced for survival to the period 1958-1960. The survivors and the members of the nonexposed component of the sample differ markedly with respect to history of foreign residence prior to the A-bombing, the nonexposed much more frequently reporting such residence. At the closer distances to the hypocenter shielding was, on the average, greater in Nagasaki than in Hiroshima. In consequence, burns and acute radiation injury were more prevalent in Hiroshima than in Nagasaki for survivors within 1000 meters. For the third analysis 8614 deaths were observed in the sample. The causes most frequently assigned to the deaths were vascular lesions of the central nervous system and malignant neoplasms. The nonexposed members of the sample had lower mortality ratios than did the survivors at all distances. Mortality ratios for survivors within 1400 meters were higher than for survivors at greater distances for all causes, all natural causes, tuberculosis (Hiroshima males), leukemia, and other malignant neoplasms. Mortality ratios from all causes in those located within 1400 meters of the hypocenter were especially high in 1951-1952, and declined thereafter. Ratios for death from malignant neoplasms in the same group declined from 1951-1952 to 1957-1958, then increased in 1959-1960. Data are tabulated. (auth)

25999 THE GENETIC CONTROL OF RADIOSENSITIVITY IN PSEUDOMONAS AERUGINOSA. B. T. O. Lee and B. W. Holloway (Melbourne Univ.). Radiation Res., 25: 68-77 (May 1965).

Differences in sensitivity to ultraviolet light between two strains of Pseudomonas aeruginosa were found to be genetically controlled. The genes involved segregate in crosses between the two strains; an attempt was made to determine the number involved and their location. Mutants with altered radiosensitivity were obtained after treatment with nitrosoguanidine. (auth)

26000 ABSCOPAL EFFECTS OF WHOLE-BODY X-IRRADIATION ON COMPENSATORY HYPERTROPHY OF THE RAT KIDNEY. L. W. Wachtel and L. J. Cole (Naval Radiological Defense Lab., San Francisco). Radiation Res., 25: 78-91 (May 1965).

The weight and DNA content of normal growing (intact) and hypertrophying (after uninephrectomy) rat kidneys were obtained from several hundred Sprague-Dawley white rats. The effects of whole-body x irradiation with 500 Rads and of local irradiation to the kidney with 1000 Rads were then determined by following the rate and degree of hypertrophy and the DNA content of the kidney. When calculated on the basis of body surface area, a constant ratio of kidney weight and of kidney DNA was found in the normal, nonhypertrophying kidneys of rats 5 to 12 weeks old. After 21 days of hypertrophy these values increased approximately 50% over normal in rats 4 to 6 weeks old at the time of nephrectomy. For animals 6 to 14 weeks old at the time of nephrectomy the corresponding increase was only about 20%. After uninephrectomy and x irradiation with 1000 Rads to the exteriorized remaining kidney, 4-week-old rats whose bodies were lead-shielded during irradiation showed no retardation in body weight growth, no significant difference in the DNA content of the kidney, and a small but significant decrease in weight increment of the hypertrophying kidney after 21 days. Rats exposed to 500 Rads of x rays with the kidney shielded during irradiation, when compared with nonirradiated controls, showed retardation of body weight growth, a reduction in the DNA content of the kidney, and a reduction in the amount of kidney hypertrophy 21 days after uninephrectomy. A still greater inhibition of both kidney compensatory hypertrophy and the increase in DNA content of the kidney occurred after 500 Rads of whole-body irradiation. Food restriction in nonirradiated 4-week-old rats, resulting in retardation of body weight growth, elicited a marked reduction in kidney weight and in DNA content of the hypertrophying kidney 21 days after uninephrectomy. It was concluded that the reduction in kidney hypertrophy after whole-body x irradiation with 500 Rads is due in some measure to an abscopal or indirect effect, secondary to decreased body weight. (auth)

26001 POSTIRRADIATION GROWTH, DIVISION, AND RECOVERY IN BACTERIA. Howard I. Adler and Alice A. Hardigree (Oak Ridge National Lab., Tenn.). Radiation Res., 25: 92-102 (May 1965).

A method for predicting conditions that will stimulate colony formation in irradiated bacterial populations is described. It is based on the observation that, in some bacterial strains, inactivation by ionizing radiation results from damage to the division mechanisms. In these strains, growth is not inhibited, but there is a failure in the cell division mechanism. This failure causes the production of microscopically visible nonseptate filaments during postirradiation incubation on nutrient media. Such filaments can be induced to divide by exposure to pantoyl lactone, growth on minimal synthetic medium, or incubation at elevated temperatures. In strains inactivated by damage to growth mechanisms, little or no filament formation is observed. These strains respond to growth-promoting agents such as rich media and low incubation temperatures. (auth)

26002 RECOVERY FROM SUBLETHAL X-RAY DAMAGE IN SURVIVING YEAST CELLS. Silvia Bacchetti and Francesco Mauro (Universita, Rome). Radiation Res., 25: 103-114 (May 1965).

Experiments were performed on log phase unstarved yeast cells, by using x-ray fractionated doses, in order to investigate the kinetics of recovery from sublethal damage. The results were compared with those obtained by others using mammalian cells and by those using starved diploid yeast cells from the lag phase. The recovery kinetics of log phase cells showed a marked similarity to those observed in several kinds of mammalian cells and in other organisms. The decrease in survival observed during the recovery process could be explained by a synchronization induced by the first x-ray dose, probably producing an accumulation of the cells in a more radiosensitive state. (auth)

26003 NEUTRON-INDUCED DENTAL FRAGILITY. Donald G. Willhoit, William K. Collett, and Niel Wald (Univ. of Pittsburgh). Radiation Res., 25: 115-22 (May 1965).

After whole-body fission neutron irradiation of Sprague-Dawley rats, a high incidence of dental defects was observed at neutron doses significantly lower than those previously reported. A recurrence of the defects in the regenerated incisor teeth was also noted. Enamel formation disturbance was seen in animals exposed to 80 Rads. Interference with dentin formation resulting in osteodentin and dentin niches in the labial aspect of the incisors was observed after 125 and 170 Rads. All mandibular incisors fractured within 45 days, and 75% of the maxillary in-

cisors fractured eventually, after exposure to 220 Rads or 240 Rads. The mandibular incisors began to fracture approximately 35 days after exposure, and the maxillary incisors about a week later. The time of appearance of the fractures seemed to correspond very closely to the time of eruption of the dentin niche from the supporting bone. The fact that some teeth exhibiting these gross structural defects fractured a second time tends to support the possibility that some degree of permanent damage is inflicted upon the developing tooth germ. It was concluded that neutron irradiation affects the developing incisor teeth of rats in a manner very similar to that of x irradiation. In addition, it was also concluded that fission neutrons can elicit these dental defects at exposure levels approximately one-fourth that of x rays. This would tend to indicate a relative potency of about 4 for fission neutrons in this biological system. (auth)

26004 THE DEPENDENCE OF RBE ON THE ENERGY OF FAST NEUTRONS. IV. INDUCTION OF LENS OPACITIES IN MICE. G. R. Merriam, Jr. (Columbia-Presbyterian Medical Center, New York), B. J. Biavati, J. L. Bateman, H. H. Rossi, V. P. Bond, L. Goodman, and E. F. Focht. Radiation Res., 25: 123-38(May 1965).

The RBE for the induction period of lens opacities in mice by monoenergetic neutrons was determined. The data are analyzed by a method that has general applicability to RBE studies. The results indicate that in general the RBE increases from about 4.5 to about 9 as the neutron energy decreases from 1.8 to 0.43 Mev. An exception to this may be a higher RBE at 1.8 than at 1.5 Mev. A possible explanation for the occurrence of such an anomaly is outlined. (auth)

26005 GAMMA-RAY-INDUCED PERMEABILITY CHANGES IN RELATION TO EARLY MORTALITY IN THE CHICK. Emily J. B. Christian and S. Phyllis Stearner (Argonne National Lab., Ill.). Radiation Res., 25: 146-57 (May 1965).

In the 3-day-old chick, early mortality (death within 1 to 2 days) produced with ^{60}Co γ irradiation was characterized by hypotension, sluggish circulation, hemorrhage, and edema. The existence of a radioinduced increase in vascular permeability was indicated by the rapid alterations in concentration of plasma proteins. Loss of albumin began almost immediately after exposure to 1400 R in 10 minutes and continued until death. Loss of plasma volume probably occurred after the decrease in albumin concentration. By 24 hours, more than 99% mortality had occurred in the 1400-R group. After a dose of 700 R in 10 minutes, the loss of plasma albumin was more gradual and began to return to normal levels by 24 hours. In this group, less than 10% mortality occurred in the early period. When the radiation was extended over a longer exposure period (for example, 24 hours), a much larger dose was required to produce a comparable protein loss. Only after a 24-hour protracted dose of 12,800 R could a similar albumin loss or early mortality be demonstrated. This indicates that these permeability changes are dependent on exposure time as well as on delivered dose. It is suggested that the rate of protein loss and subsequent loss in plasma volume may be the factors that are critical for survival. (auth)

26006 INCORPORATION OF H^3-PHENYLALANINE INTO SERUM PROTEINS BY THE PERFUSED LIVER OF NORMAL AND X-IRRADIATED RATS. A. Sassen, G. B. Gerber, F. Kennes, and J. Remy-Defraigne (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Radiation Res., 25: 158-63(May 1965).

Incorporation of ^{3}H-phenylalanine into serum proteins by the perfused liver of normal and irradiated rats was studied. Changes with time in total radioactivity of phenylalanine and in blood were the same in both groups. Incorporation into α_1- and β-globulins was increased and incorporation into albumin decreased slightly in the irradiated liver. Synthesis of prealbumin and α_2-globulins was not significantly changed. (auth)

26007 PROTECTION AGAINST ACUTE RADIATION ULCERATION IN HEALING RAT EPIDERMIS. J. F. McGregor (Atomic Energy of Canada Ltd., Chalk River, Ont.). Radiation Res., 25: 164-70(May 1965).

The incidence of x-ray-induced ulceration was studied in superficially wounded skin and in uninjured skin, with mutant hairless and black-hooded rats and localized doses of 7200 and 1800 R. A significant reduction ($P = <0.01$) in the number of animals with ulcers was found in skin that was irradiated 48 hours after injury. Protection against x-ray ulceration is believed to be due to speedier re-epithelization of the burned area, as a consequence of healing in the shielded portion of the wounded skin. (auth)

26008 SHORT-WAVE IRRADIATION OF HEPATIC REGION AND THE UTILIZATION OF GLUCOSE. A. Baronchelli, M. Passeri, and E. Iori (Universita, Parma, Italy). Radiobiol. Radioterap. Fis. Med., 19: 10-23(Jan.-Feb. 1964). (In Italian)

Short wave irradiation of the hepatic region during the first half hour after oral administration of glucose, suppresses glucemia. Differential glucemia is also lower during the first half hour of the treatment. Results are explained in terms of hepatic glycogenesis by short waves. It is further suggested that certain hepatic diseases may be cured by short wave irradiation. (H.G.D.)

26009 BEHAVIOR OF ENTEROCHROMAFFIN CELLS IN THE INTESTINES OF A HEDGE HOG IRRADIATED DURING HIBERNATION PERIOD. A. Cavina Pratesi and F. Ghiringhelli (Universita, Pavia, Italy). Radiobiol. Radioterap. Fis. Med., 19: 133-43(Mar.-Apr. 1964). (In Italian)

The effects of irradiation on the enterochromaffin cells were studied in hibernating ground hogs. Control groups in the awakened state were also observed. Results are interpreted to suggest that diarrhea in irradiated subjects may also be caused by discharge of enteramines. (H.S.D.)

26010 CLINICAL CONTRIBUTIONS TO THE STUDY OF PROCTOSIGMOIDETIC LESIONS FROM RADIATION. G. Peracchia and G. Gagnoni-Schippisi (Universita, Parma, Italy). Radiobiol. Radioterap. Fis. Med., 19: 145-77(May-June 1964). (In Italian)

The most recent literature on the proctosigmoidetic lesions induced by radiation is reviewed, and five cases of retarded lesions with reduction of the intestinal tube lumen are presented. Two of these are secondary to radiotherapy for uterus neoplasmus and three secondary to telecobalt therapy for vesical tumors. Patients are encased in the statistics of the Radiology Institute of Parma University. Considerations are made on etiology, time of appearance and treatment of the individual cases. (auth)

26011 STUDY OF THE DISTRIBUTION OF RADIOACTIVE PHOSPHORUS IN IRRADIATED RATS. SOME RADIOSENSITIZING ACTION. G. Dragoni and G. Bagliani (Universita, Milan and Universitat, Pavia, Italy). Radiobiol. Radioterap. Fis. Med., 19: 204-22(May-June 1964). (In Italian)

The radiosensitizing effect of synkavit and of cyclohexanol on the fixation of radioactive phosphorus in the kidney and liver of rats subjected either to whole-body irradiation or to irradiation of kidney was studied. Irradiation causes an increase in ^{32}P uptake by the tissues, an effect which is potentiated by the radiosensitizers studied. The histologic and autoradiographic findings on renal and hepatic tissue are also described. (auth)

26012 MODIFICATIONS IN THE INTESTINAL FLORA IN PATIENTS SUBJECTED TO RADIUM THERAPY FOR NEOPLASIA OF THE PORTIO UTERINA. M. Zanetti and G. F. Schiavi (Universita, Bologna). Radiobiol. Radioterap. Fis. Med., 19: 291-304(July-Aug. 1964). (In Italian)

The modifications taking place in the intestinal flora were studied in 18 female patients under treatment at the Bologna L. Galvani Radium Institute for neoplasia of the portio uterina. Nine were treated with radium therapy associated to traditional roentgen therapy and nine with telecobalt therapy. A series of bacteriological tests were carried out for this purpose on the excreta of the patients prior to, in the middle of, and at the end of the radiation cycle. The results achieved enabled the researchers to

note an increase in the overall bacterial charge in 61.11% of the samples analyzed, an increase in the coliform bacteria (in 66.66%), and in the staphylococci (in 72.22%), as well as an increase in the staphylococci strains with pathogenic characteristics. It is suggested that such alterations depend on a change in the environment conditions caused by the radiations, especially the anatomical and functional alterations taking place on the intestinal wall. (auth)

26013 OBSERVATIONS OF ULTRASTRUCTURAL CHANGES IN THE LIVER CELLS OF RABBITS EXPOSED TO WHOLE-BODY IRRADIATION. COMPARISONS BETWEEN ULTRASTRUCTURAL CHANGES AND ONES INDUCED BY DIFFERENT CAUSES. B. Birarelli and F. Levis (Centro per la Diagnosi e Cura dei Tumori, Ancona, Italy). Radiobiol. Radioterap. Fis. Med., 19: 305-25(Sept.-Oct. 1964). (In Italian)

The ultrastructural changes induced in the liver cells by the whole-body irradiation were studied in rabbits exposed to single 600 r doses of x rays. The animals were sacrificed after 12, 24, and 36 hours. Changes of the whole cytoplasmatic structures were shown particularly of hydropic-vacuolar and lytic types. The possibility of reconstructing the cronological evolution of ultrastructural changes is ascribed to employment of relatively small doses and to protraction of observation time. Any comparison between post-radiation ultrastructural changes and the ones induced by toxins and infections shows that the alterations induced are substantially non-specific and uniform, whatever the nature of damaging agent. (auth)

26014 ON POST-IRRADIATION MODIFICATIONS IN THE BLADDER. F. Bono, A. Corinaldesi, and A. Maver (Universita, Bologna). Radiobiol. Radioterap. Fis. Med., 19: 326-44(Sept.-Oct. 1964). (In Italian)

Clinico-experimental research was carried out to study the cystometric post-irradiatory alterations of the bladder and their correlations with the histological findings and the administered doses. The irradiation of the bladder in laboratory animals and patients with cervical neoplasms in the I and II stages caused alterations of the bladder walls (edema, phlogosis, sclerosis) to which particular cystometric curves correspond. Such alterations are in connection with the entity of the radiations administered and the time elapsed since the radiotherapy. On the basis of the results it is concluded that cystometric research provides useful indications of the functional post-irradiatory alterations of the bladder walls. (auth)

26015 PHYSICOCHEMICAL EFFECTS OF IONIZING RADIATION ON DNA. Yu. V. Vinetskii. Radiobiologiya, 5: 3-10(1965). (In Russian)

Gamma irradiation of DNA irreversibly damaged the hydrogen bonds of the macromolecules; the radiation effect on the secondary structure did not depend on the amount of the G-C components. Ethyl alcohol prevented damage to the hydrogen bonds. The chief physico-chemical damage caused by irradiation of DNA in nucleoprotein particles of bacteriophage T-2 of E. coli B was depolymerization, but the stability of the hydrogen bonds was not destroyed. DNA isolated from a phage suspension irradiated to 25 kR (1.2 to 1.4 times the lethal amount) was shown by sedimentation and viscosimetric analysis to be a half molecule of phage DNA. It was concluded that the macromolecule is ruptured in pre-existing weak spots and that basically the process may be one of transfer of the radiation energy. (tr-auth)

26016 REACTION OF PARAMECIUM CAUDATUM TO THE CHRONIC ACTION OF SMALL SINGLE AND FRACTIONAL DOSES OF ULTRAVIOLET RADIATION. E. I. Zaar (Inst. of Cytology, Leningrad). Radiobiologiya, 5: 169-73(1965). (In Russian)

Irradiation of Infusoria for 10 to 15 days with daily doses of 20 to 40 μ of short-wave uv (2537 A) delayed division in the dark. The combined action of uv and visible light did not delay multiplication of the organisms. Fractionated uv irradiation over a period of many days caused a delay in the dark variant at a total dose of 100 to 260 μw, i.e. $\frac{1}{6}$ to $\frac{1}{3}$ of the single-irradiation sublethal dose. The reaction of Infusoria at equal daily doses was not uniform, the longer the irradiation period, the greater was the cell damage. (tr-auth)

26017 INTENSITY OF CHOLESTEROL METABOLISM IN SPLEEN AND MUSCLES OF IRRADIATED RATS. M. F. Vinogradova (Leningrad State Univ.). Radiobiologiya, 5: 218-20(1965). (In Russian)

A single whole-body x irradiation of 800 R increased the incorporation of acetate-^{14}C in the cholesterol of rat spleens as well as the amount of cholesterol in the spleens. The specific activity of the blood cholesterol changed in a wave-form manner, often being below normal. Cholesterol metabolism of muscle tissues changed less than that of the spleen, the amount of cholesterol and its specific activity after irradiation being little different from normal. (tr-auth)

26018 ON THE PROBLEM OF THE IMPORTANCE OF NEURO-ENDOCRINE CHANGES IN REMOTE AFTER-EFFECTS OF IRRADIATION. P. D. Gorizontov, B. B. Moroz, V. P. Fedotov, A. F. Bibikova, and N. K. Evseeva. Radiobiologiya, 5: 221-6(1965). (In Russian)

In 12 of 15 dogs living 3 to 5 years after acute radiation sickness resulting from mixed gamma-neutron irradiation, internal disturbances were found by functional tests. The sequelae were, characteristically, nontypical local damage to the adrenals, apparently related to selective damage to synthesis processes in different regions of the cortex. Analysis of the mechanisms taking place in the hypofunctional state of the adrenal cortex indicated that it may develop as damage to the pituitary-adrenal cortex system with increase in the cortical tissue in the irradiated organism. Deep destructive changes were observed in the neurosecretory centers of the hypothalamus, which are usually related to changes in the pituitary. (tr-auth)

26019 ON THE ROLE OF SYMPATHETIC INNERVATION IN CHANGES OF FUNCTIONAL STATE OF ADRENAL GLANDS DURING IRRADIATION. E. N. Petrovnina. Radiobiologiya, 5: 227-30(1965). (In Russian)

In experiments on rats, sympathetic effects were found to play an important role in the increase in the adrenal medulla function in irradiated (ionizing) organisms. With preliminary denervation of the adrenals, internal and external irradiation decreased rather than increased, non-adrenalin production. Preliminary denervation had less effect on adrenalin production in damaged animals. Except for the sympathetic effect on the adrenals, there was no change in adrenalin metabolism in the direction of its increased oxidation that is characteristic for radiation sickness. The adrenalin increase in denervated adrenals at a definite period in the radiation sickness indicates a humoral stimulation of adrenalin production. (tr-auth)

26020 HEMATOLOGICAL AND CHEMICAL ANALYSIS OF BLOOD OF DIFFERENT PARTS OF MONKEY BRAIN AFTER γ IRRADIATION. Lyong T'and Chuong, Nguen Hui Chan, Lyong Tang Tuan, Nguen Thi Thin, and I. A. Sytinskii (Hanoi Univ., Vietnam; Bak-Mai Hospital, Vietnam; and Leingrad State Univ.). Radiobiologiya, 5: 268-74(1965). (In Russian)

Monkeys were gamma irradiated (^{60}Co) to 800 R. In the peripheral blood the plasma albumin fraction decreased and the α- and β-globulin increased. The γ-aminobutyric acid level in the gray matter of the cerebral cortex of the large hemisphere decreased at first but increased after 3 days. The glutamic acid level decreased gradually. Photomicrographs of the spleen are shown. (tr-auth)

26021 FORMATION OF METHEMOGLOBIN IN RABBITS BY INJECTION OF CHEMICAL RADIOPROTECTORS. N. I. Bicheikina. Radiobiologiya, 5: 293-4(1965). (In Russian)

Internal administration of sodium nitrate, p-aminopropiophenone, and p-aminobutyrophene to rabbits caused significant methemoglobinemia, similar in type and duration for the three chemicals. The nature of the methemoglobinemia was the same in irradiated and unirradiated animals. An 800-R gamma dose resulted after 180 min, in a blood

methemoglobin level of 15.8 ± 6.0% compared to normal. (tr-auth)

26022 INFLUENCE OF OXYGEN PRESSURE AT THE TIME OF IRRADIATION ON THE LEVEL OF METABOLISM OF PHOSPHORUS-CONTAINING COMPOUNDS IN VICIA FABA ROOTS. N. G. Nor-Arevyan (Scientific-Research Inst. of Agriculture, Echmiadzin, USSR). Radiobiologiya, 5: 301-3(1965). (In Russian)

High pressures of oxygen and nitrogen, to 50 atm, had no marked effect on exchange of ^{32}P compounds in horse beam rootlets. Irradiation to 150 R decreased the exchange of phosphoric esters of carbohydrates, nucleic acids, and phosphoproteins, the effect being greater when the irradiation was done in oxygen. (tr-auth)

26023 COMPARISON OF EFFECTS OF FAST NEUTRONS, X RAYS AND UV LIGHT WITH THAT OF CHEMICAL MUTAGENS IN SELECTION OF ACT. ANTIBIOTICUS. N. K. Zhdanov, N. I. Zharova, and S. I. Alikhanyan (All-Union Scientific Inst. of Antibiotics, Moscow). Radiobiologiya, 5: 394-8(1965). (In Russian)

The comparison of five mutagenic factors based on the frequency of variant induction with high efficiency showed a significant advantage for only fast neutrons over uv light. The other mutagens were x rays, diethyl sulfate, and ethyleneimine. Selectivity comparison of ionizing radiation with ethyleneimine showed the radiation to be much more effective than the chemical or natural selection. (tr-auth)

26024 EFFECT OF LOW-DOSE γ IRRADIATION ON THE GROWTH AND DEVELOPMENT OF COTTON. D. T. Kabulov, M. M. Muminov, and F. I. Ismailov (Samarkand State Univ., USSR). Radiobiologiya, 5: 309(1965). (In Russian)

A four-year study indicated that pre-sowing gamma irradiation of cotton seeds improves density of stand, number of bolls per plant, and harvest yield (in hundred weight per hectare). The optimum radiation dose was 600 R. (IIC-M.G.)

26025 β-IRRADIATION INFLUENCE ON FREQUENCY OF SYSTOLES IN MOLLUSK EMBRYO. O. I. Patrusheva and I. A. Tarchevskii (Kazan State Univ., USSR). Radiobiologiya, 5: 314(1965). (In Russian)

Studies on the length of life of embryonic mollusks indicated that they are much more resistant to irradiation than are mammal embryos and have approximately the same resistance as chicken embryos. (tr-auth)

26026 A STUDY OF FIVE SUBJECTS SUBJECTED TO AN ACCIDENTAL SUBACUTE TOTAL IRRADIATION. R. Gonzalez and L. Berumen (Commission Nationale de l'Energie Nuclear, Mexico City). Rev. Franc. Etudes Clin. Biol., 8: 1009-11(1963). (In French)

A ten-year old boy received an estimated 4700 R during 10 days' exposure to a capsule of ^{60}Co, which he had found and carried in his pants pocket before placing it in a kitchen cabinet. An infected burn was found on his left thigh. Pancytopenia was present: hemoglobin was 6.1 g/100 cm^3 and leucocytes were 600/mm^3, of which 64% were lymphocytes. He died in a month. His mother, six months pregnant, received 3500 R over 57 days. Pancytopenia was present: hemoglobin, 4.5/100 cm^3; leucocytes, 200/mm^3; and thrombocytes, 12,000/mm^3. In spite of blood transfusions, she died within 20 hours of hospitalization. An autopsy confirmed a severe medullary aplasia. In the fetus, splenic lymph nodules were absent. The boy's three-year-old sister received 2870 R over a period of three months. After ~ one month she developed a "rash". After two months a fever and symptoms of respiratory infection appeared. At three months a hematologic examination revealed severe anemia, thrombocytopenia, and leucopenia. Purpura developed. Blood transfusions and antibiotics did not help. She presented signs of a profound anemia, hemorrhagic syndrome, 40°C fever, and a marked pigmentation of the nails. A hematologic examination revealed severe pancytopenia: hemoglobin, 10.7 g/100 cm^3 and leucocytes, 100/mm^3. Thrombocytes were very rare. In smear preparations of her bone marrow, myeloid cells were rare: 15% erythroblasts, 4% granulocytes, and no megakaryocytes. She died soon after examination. The grandmother received an estimated 3000 R during 49 days. A hematologic examination revealed anemia (4.9 g/100 cm^3) with leucopenia (2000/mm^3). She was hospitalized with a hemorrhagic syndrome and a right pulmonary infection. Her nails were pigmented and there was moderate loss of hair. She received blood transfusions, antibiotics, and corticoadrenal steroids, but her marrow remained severely hypoplasic and she died one month later. The father received an estimated 1200 R over 48 days, causing fatigue and nail pigmentation. An examination revealed leucopenia (4150/mm^3) and moderate thrombocytopenia (180,000/mm^3). His marrow was slightly hypoplasic. He was treated with corticoadrenal steroids and recovered. In all cases, there were no digestive manifestations of the irradiation. The nail pigmentation was unexpected. No allogenic bone marrow grafts were attempted because of the uncertainty of the prognosis and the lack of experimental data demonstrating the success of such a graft after subacute irradiation. (BBB)

26027 AN ATTEMPT TO SENSITIZE, BY 6-MERCAPTOPURINE AND BY THE ASSOCIATION OF 6-MERCAPTOPURINE AND 5-BROMODEOXYURIDINE, THE EFFECTS OF IRRADIATION ON ALLOGENIC SKIN GRAFTS. Homai Da Costa, Rose Tenenbaum, and Anne-Marie Mery (Hopital Saint-Louis, Paris). Rev. Franc. Etudes Clin. Biol., 9: 90-2(Jan. 1964). (In French)

F_1 (DBA/2 × BALB C/c) (H-2^d × H-2^d) mice received a skin graft from C^{57} Br (H-2^k) donors. They were then divided into 10 groups: 1) control mice which received no irradiation or injections; 2) mice x irradiated on graft day −1; 3) mice receiving only 6-mercaptopurine, a) on days +4 to +9, b) on days 0 to +5, or c) on days −3 to +2; 4) mice receiving 6-mercaptopurine plus 5-bromodeoxyuridine, a) on days +4 to +9, b) on days 0 to +5, or c) on days −3 to +2; 5) mice irradiated on day −1 and given 6-mercaptopurine on days +4 to +9; and 6) mice irradiated on day −1 and given 6-mercaptopurine plus 5-bromodeoxyuridine on days +4 to +9. All irradiations were 400 rad in toto. 6-Mercaptopurine was injected in 24 mg/kg doses and 5-bromodeoxyuridine, in 30 mg/kg doses. In the control group the grafts survived seven to 12 days with a median of nine days. In groups 2 and 3a the median was 10 days, with extremes of seven to 17 and seven to 14 days. In groups 3b, 4b, 4c, and 5 the graft had a median survival time of 12 days. The extremes of tolerances were seven to 12, eight to 18, eight to 20, and eight to 21 days, respectively. Group 3c had a median survival time of 13.5 days with extremes of 10 to 17 days. Group 4a's median time was only 9.5 days, with extremes of seven to 12 days. This result was not as good with 6-mercaptopurine administered alone (group 3a). In group 6 a greater tolerance was induced, with some grafts lasting as long as 30 days. The grafts in this group, using irradiation and 6-mercaptopurine plus 5-bromodeoxyuridine, had a median survival time of 17 days. (BBB)

26028 STUDY OF THE MITOTIC INDEX IN BONE MARROW AND OF THE INCORPORATION OF ^{59}Fe INTO ERYTHROCYTES AFTER GAMMA IRRADIATION OF THE RAT. D. Mechali, M. Taranger, S. Ledermann, and F. Godiniaux (Commissariat a l'Energie Atomique, Paris). Rev. Franc. Etudes Clin. Biol., 9: 829-38(Oct. 1964). (In French)

In cases of accidental irradiation when no physical dosimetry data are available, it is difficult to treat the subject effectively unless biologic indices of the dose received are evident. These studies were conducted to develop a method for assessing the absorbed dose according to biologic criteria. Hematopoiesis was studied in rats after ^{60}Co irradiation at doses of 100, 200, 300, 500, 644, 700, and 720 rad. An attempt was made to correlate irradiation dose with marrow injury by two methods. In the first method the erythrocyte and granulocyte series mitotic indices were determined three days after irradiation using four rats for each dose, with 10 controls serving to establish the normal values. At the 500-rad dose (⅔ of the 30-day LD_{50}) the mitotic indices were studied for 28 days after irradiation.

In the second method, red cell incorporation of ^{59}Fe was observed after injection three days after irradiation in 8 rats, as compared with 8 controls, with blood activity measured four days after injection. Both methods showed that the greater the irradiation dose the more severe the depression of marrow activity. The mitotic index gives a wide scatter of results due to individual variations, whereas ^{59}Fe incorporation gives more homogeneous results and shows a direct relation of marrow depression to dosage. It was observed that doses of radiation (100 to 200 rad) well below the lethal range stimulated rather than depressed ^{59}Fe incorporation in erythrocytes. The linear relation between ^{59}Fe red cell uptake and dose holds over the range 300 to 500 rad. (BBB)

26029 ELECTROPHORETIC STUDIES ON SERUM AND TISSUE PROTEINS OF THE LIVER TUMORS IN PATIENTS BEARING MALIGNANT TUMORS. PART I. ELECTROPHORETIC STUDIES ON SERUM AND ASCITES PROTEINS OF ORGANISMS BEARING MALIGNANT TUMORS AND EFFECT OF RADIATION AND OTHER AGENTS ON THEM. I. INFLUENCE OF RADIATION ON ELECTROPHORETIC PROPERTIES OF SERUM PROTEINS OF UTERINE CANCER PATIENTS. Hirokazu Kaji (Kyoto City Univ.). Sanfujinka No Shinpo, 14: 205-10(Sept. 1962). (In Japanese)

Groups of uterus cancer patients, untreated and radiation-treated, plus a control group of healthy nurses, were studied. Blood was taken from the antecubital vein, and centrifuged at 3000 rpm for 15 min to separate serum. The total serum protein concentration (TP) was measured refractometrically and serum protein fractionations were measured by electrophoresis. Two groups of radiation-treated patients were distinguished: (A) Those irradiated after surgical removal of the uterus; (B) Those irradiated without surgery. The former group was irradiated starting 20 to 30 days after the operation. X irradiation (200-kv) of 426 R (127 R at 10-cm depth) per treatment week from a distance of 40 cm from the skin, one treatment cycle totaling 6816 to 10,224 R over the pelvis during one week, was administered. In others, ^{60}Co irradiation was administered from a distance of 30 cm from the skin with 232 R (105 R at depth of 10 cm) per session, totaling 3612 to 5568 R over the pelvis to complete one treatment cycle. In some cases, Ra implantation was also performed for five hr/day for 16 days, giving a total of 4000 R. In group A patients, compared with the nonpregnant healthy control group, TP decreased gradually with the progression of cancer, and its decrease was significant in cases of stage III and IV cervical cancer and the cases of cancer in the corpus uteri. Albumin decreased with the progress of cancer, with significance from stage II on. α-Globulin increased gradually with the progression of cancer with significance from stage II. β-Globulin showed no significant variation. γ-Globulin increased gradually with the progress of cancer to a significant percentage from stage II in relative but not absolute amount. In the x-irradiated A group the TP did not vary in the first treatment week but decreased in the second treatment week, as it did also in the B group. An increase of TP was noted in the third week in the A group. Albumin decreased in both A and B groups for first and second week, but showed a nonsignificant increase in the third week of treatment. α-Globulin tended to increase for the first and second week in the A group and β-globulin showed no marked variation. γ-Globulin increased in the A group for the first week and in the B group, but decreased in the A group in the second and third week. Albumin/globulin ratio (A/G) increased only in the A group in the third week, and decreased in other cases. In general, the A group showed less variation than the B group, and tended to show improvement of protein levels with the progress of radiation treatment. With ^{60}Co treatment, TP, albumin, and A/G showed an insignificant decrease, and the globulins showed no significant variation. No significant difference was seen between the two patient groups. Generally, a similar variation in serum protein electrophoretic fractions was seen with the x-ray and ^{60}Co treatments; Ra treatment showed less influence on proteins than the x-ray of ^{60}Co treatments (BBB)

26030 ELECTROPHORETIC STUDIES ON SERUM AND TISSUE PROTEINS OF THE LIVER AND TUMORS IN PATIENTS BEARING MALIGNANT TUMORS. PART I. ELECTROPHORETIC STUDIES ON SERUM AND ASCITES PROTEINS OF ORGANISMS BEARING MALIGNANT TUMORS AND EFFECT OF RADIATION AND OTHER AGENTS ON THEM. 2. INFLUENCE OF RADIATION AND VARIOUS ANTICANCER AGENTS ON ELECTROPHORETIC FRACTIONS OF NORMAL AND YOSHIDA SARCOMA-IMPLANTED RAT SERUM PROTEINS. Hirokazu Kaji (Kyoto City Univ.). Sanfujinka No Shinpo, 14: 210-18(Sept. 1962). (In Japanese)

Normal Wistar rats and Yoshida tumor-implanted rats were used to study the effects of radiation and various antitumor chemotherapeutic agents on electrophoretic patterns of their serum proteins. To lessen toxicity and to protect the liver from the side-effects of the antitumor agents and radiation, a liver-protective agent was tested for effectiveness. Various amino acids and protein-anabolic hormones were also tested for their effects on serum protein levels. After the implantation of Yoshida tumor in the rats, they were wholebody x irradiated with 600 R, and sacrificed after 24 to 72 hr. Another group of rats were γ irradiated with ^{60}Co to total 600 R, and sacrificed after 24 hr. Antitumor agents tested were triethylene thiophosphoramide (TEPA) and mitomycin (MC). As a liver toxin, CCl_4 was used, and as a liver protectant, thioctic acid (TA). The amino acid mixture tested was Moromin-S (MoS); androgenic hormones were testosterone propionate (TP) and norandrosterone phenylpropionate (NAPP). These agents were all injected intraperitoneally in doses of: TEPA and MC, 3.5 mg/kg; CCl_4, 1.5 ml/kg; TA, 5 mg/kg/day for 7 days; MoS, 4 ml/kg/day for 7 days; TP, 20 mg/kg/day for 7 days; NAPP, 20 mg/kg/day for 2 days. To test its liver-protective effect, TA was administered to tumorous rats which then were x irradiated with 600 R or given TEPA (3.5 mg/kg for 3 days), and were sacrificed seven days after the tumor implantation. Blood was taken from the thigh vein, and total protein TP and serum proteins were studied following the same procedures as for the human serum in the preceding experiments. The results showed that in normal rats, x irradiation brought about no marked variation in TP, but a decrease in albumin, increase in globulin, and lowering of the albumin/globulin (A/G) ratio. In rats given TEPA no variation in TP, a significant decrease of albumin, increase of α-γ-globulin, and decrease of A/G were seen. In rats given T-P, no marked variation was seen. In those given CCl_4, decrease of TP and albumin, increase of α-γ-globuiins, and marked lowering of A/G were seen. In tumor-bearing rats, there was a marked decrease of TP and albumin, an increase of various globulins, and a marked lowering of A/G. X irradiation effected no marked variation in TP, but caused a decrease of albumin and an increase of α-globulin. It caused no marked variation in β-γ-globulins, but a lowering of A/G. The ^{60}Co-irradiated group showed no marked variation of TP, but a decrease of albumin. There were no marked variations in α-β-globulins, but an increase in γ-globulin and a decrease of A/G were noted. In rats with tumors given TEPA, it caused no marked variation in TP, but a marked decrease of albumin and an increase of various globulins, and a marked lowering of A/G; this group showed the most marked variations among the experimental series. In MC-treated tumorous rats, albumin decreased and α-globulin increased. With MoS, no marked variation was seen except a slight increase of albumin. After TA, TP increased slightly and albumin increased markedly, but γ-globulin decreased. A/G increased significantly, showing improvement in protein levels. Administration of TA seemed to lessen somewhat the harmful effect of TEPA and x radiation. In tumorous rats given TP, albumin increased, but γ-globulin tended to decrease. After NAPP, albumin tended to increase and α-globulin to decrease, but otherwise no marked variations were seen. (BBB)

26031 ELECTROPHORETIC STUDIES ON SERUM AND TISSUE PROTEINS OF THE LIVER AND TUMORS IN PATIENTS BEARING MALIGNANT TUMORS. PART I. ELECTROPHORETIC STUDIES ON SERUM AND ASCITES PRO-

TEINS OF ORGANISMS BEARING MALIGNANT TUMORS AND EFFECT OF RADIATION AND OTHER AGENTS ON THEM. 3. INFLUENCE OF VARIOUS CHEMICAL AGENTS ON ELECTROPHORETIC PROPERTIES OF THE YOSHIDA SARCOMATOUS ASCITES PROTEINS OF RATS. Hirokazu Kaji (Kyoto City Univ.). Sanfujinka No Shinpo, 14: 218-20 (Sept. 1962). (In Japanese)

The ascitic fluid of Yoshida sarcoma-bearing rats was centrifuged to separate by sedimentation the tumor cells, and the upper fraction of supernatant proteins was analyzed to determine the influence of the various antitumor agents. The results were compared with those for the serum proteins. When compared with the serum, total protein (TP) was markedly low in ascitic fluid, and no marked variation in albumin and α-γ-globulins; β-globulin was significantly lower and A/G somewhat higher. No marked difference in percentage of each fraction was shown except in the decrease of β-globulin, when compared with that of the serum. In rats given TEPA, no marked difference was shown in the ascitic fluid TP, when compared with the controls, but albumin decreased markedly, and α-β-globulins increased; γ-globulin showed no variation and A/G decreased. These changes showed ~ the same pattern as in serum. In rats given MoS, no marked difference was seen from the controls. When compared to the serum, TP was low but each fraction showed the same pattern as in serum. In rats given TA, no marked difference in TP from the controls was shown, but an increase of albumin, a decreasing tendency of α-γ-globulins, no variation in β-globulin, and an increasing tendency of A/G were seen. After TP, no significant variations from the controls were seen. TP showed a lower value then in serum. After NAPP, no marked variation in TP from the controls was shown. However, albumin showed an increase and α-γ-globulins a slight decrease. When compared with serum, TP and β-globulin showed a lower value and albumin a slightly higher value. (BBB)

26032 EXPERIMENTAL STUDIES ON RADIOSENSITIVITY OF VARIOUS ORGANS WITH SPECIAL REFERENCES TO NUCLEIC ACID. Yasuhiko Ito (Tohoku Univ., Sendai). Sci. Rept. Res. Inst., Tohoku Univ., Ser. C, 11: 351-69(Mar. 1964).

Studies were made to clarify the biological effects of single and fractionated whole-body irradiation in small doses and at low dose rates by examining histochemical findings and the variations in the nucleic acid concentration in the liver, spleen, kidney, and lung of rabbits. Single whole-body irradiation was made with 150, 350, 450, 650, and 750 R and the fractionated irradiation with 15.4 R per day. In order to determine radiosensitivity soon after small dose radiation, the nucleic acid metabolism and inhibition of nuclear oxidative phosphorylation were also investigated in rats under whole-body irradiation. The results showed that both irradiations had no effect on RNA in the liver, but DNA showed a decrease on single irradiation. In the spleen, both nucleic acids showed a decrease. In the kidney, RNA showed an increase in amount on single irradiation with 450 and 650 R. In the lung, RNA increased to 150% in the 150 R single irradiation group, but it decreased with an increase of dose. In the fractionated group, RNA increased at 350, 450, and 650 R, whereas DNA generally decreased. The amount of nucleic acid phosphorus of RNA and DNA showed no change at 50 R radiation in the rat. With 100 R, RNA and DNA decreased in the spleen, testis, thymus, and the small intestine. This tendency became more distinct at 500 R. No phosphorylation occurred in the liver, irrespective of the dose. (P.C.H.)

26033 EFFECT OF IONIZING RADIATION UPON THE MITOCHONDRIAL STRUCTURE AND FUNCTION. I. EARLY POST-IRRADIATION STRUCTURAL AND FUNCTIONAL CHANGES OF LIVER MITOCHONDRIA IN WHOLE-BODY IRRADIATED MICE. Fu-Yu Yang, Chih-Huan Lin, Chin-Chao Li, and Sheng-Kuang Li (Academy of Sciences, Peking). Shih Yen Sheng Wu Hsueh Pao, 9: 261-9(Sept. 1964). (In Chinese)

White male mice about 2 months old received 700 R of x rays at a dose rate of 37.5 R/min. The characteristics of swelling and the degree of coupling of oxidative phosphorylation–respiratory control and P/O ratios of mitochondria in early post-irradiation stages were then examined. The spontaneous swelling of liver mitochondria isolated from mice 30 mins and 1 hr after exposure was markedly increased. This returned essentially to normal within 4 hours. The thyroxine or Ca^{2+} induced mitochondrial swelling $\frac{1}{2}$ hr after exposure was also increased; again this change was not observed 4 hr after irradiation. The initial optical density per mg liver mitochondrial protein of normal and irradiated animals was approximately identical. On account of these observations it is suggested that a slight alteration in structural integrity is involved in the early post-irradiation stage. Concurrent with the investigation on the characteristics of mitochondrial swelling, the biochemical integrity of mitochondria–respiratory control index and P/O ratios following irradiation were also determined. The respiratory control index of mitochondria fell off 30 min after exposure and reached a minimum in 1 hour after irradiation. A slight depression of P/O ratios appeared only 1 hour after irradiation. Within 4 hours the latter recovered, whereas the former also returned nearly to control values. Besides the changes of swelling pattern, parallel with the biochemical lesion was the decrease and subsequent increase in the protein content of the mitochondrial suspension per gm of fresh liver tissue. From the results of the present study it appears that the mitochondria of mouse liver are transiently damaged both structurally and functionally by irradiation in vivo, but they are soon restored almost to pre-irradiation levels. (auth)

26034 THE LIPOID CHANGES IN VARIOUS RAT ORGANS AFTER WHOLE-BODY IRRADIATION WITH LETHAL X-RAY DOSES. II. THE BEHAVIOR OF LIVER PHOSPHATIDES AND THEIR FATTY ACIDS. Dietrich Eberhagen, Rudolf Hartung, and Nepomuk Zoellner (Universitat, Munich). Strahlentherapie, 126: 601-6(Apr. 1965). (In German)

Phospholipid concentration and fatty acid composition in the liver were studied in rats at different times after whole-body irradiation with 1500 R. The phospholipid content was practically unchanged until the animals died. Fatty acid analysis showed a decrease of the eikosatetraenoic acid concentration (arachidonic acid concentration) up to 6 hours after irradiation. Normal values of the fatty acids composition were found 48 hours after irradiation. (auth)

26035 DIFFERENT BEHAVIOR OF CHEMICALLY- AND RADIOINDUCED MUTANTS OF THE SAME GENE LOCUS (AD 7) AND MUTATION TYPE (HOT SPOT) FOR SCHIZOSACCHAROMYCES POMBE. Hedi Fritz-Niggli (Universitat, Zurich). Strahlentherapie, 126: 607-18 (Apr. 1965). (In German)

Differences in individual mutants with the same sensitive area (localized hot spot) in the ad 7-region of Schizosaccharomyces Pombe were observed after x irradiation and RNA-mutation induction. Basic differences were noted in mutants arising from radiation (uv and x rays) and mutants induced by nitrite; especially in the formation of suppressor-mutations and incomplete pink back mutations. Experimental observations showed that the mutants resulting from nitrite use were of the Akridine type (with addition or loss of base pairs), while the radioinduced mutants represent a mixture of both Akridine and transition types. The nitrite mutants (especially M 278) possibly represent operator genes which may influence RNA-synthesis of the structure genes. Investigations showed that individual mutants with the same phenotype and the same localization react quite differently to milieu factors, mutagenic agents, etc. Therefore, influences upon hereditary factors must never be generalized. (auth)

26036 THE BIOPHYSICAL EVALUATION OF UV RADIATORS WITH A SPECTRAL PATTERN APPARATUS. Dietrich Zirwer and Wilhelm Eschke (Physikalisch-Technische Institut, Deutsche Akademie der Wissenschaften, Berlin). Strahlentherapie, 126: 619-29(Apr. 1965). (In German)

A photoelectric device, based on the Vario-illuminator

principle, is described. The apparatus permits the measurement of the spectral parts of the uv radiators, as well as of the parts according to the action curves of the bacterial extermination, of the erythema production, and of the direct pigmentation. Results obtained with uv sources from several manufacturers are reported. (auth)

26037 PROLONGED FUNCTIONAL SURVIVAL OF DOG RENAL GRAFTS WITH LOCAL RADIATION. Donald C. Martin, Joseph Van DeWater, David Randel, and David A. Lee (Univ. of California, Los Angeles). Surg. Forum, 15: 156-8(1964).

The effect of local radiation on the homograft reaction was tested on kidney transplants between mongrel dogs. Radiation was used alone to see if it has a beneficial effect without use of the usual immunosuppressive drugs. The advantage of such local radiation would be that it would not interfere with the organism's normal defenses against infections while enhancing the functional survival of the homograft. Radiation to the kidney was provided by a linear accelerator (6 Mev) or ^{60}Co through a 10 × 10 cm port. Doses of radiation were 300 R and 150 R to two groups of animals. The schedule of radiation treatment covered a wide range from daily doses of 300 R to alternate days of 150 R. Six of 24 first set dog renal homografts subjected to local radiation were found to be functioning beyond the usual seven- to ten-day interval in which rejection usually occurs. Function was seen up to 17, 18, 24, 26, and 36 days. None of 13 second set dog homografts were found to have prolonged function, following irradiation of the first graft. Local irradiation in the doses of 150 R or 300 R used here should be sufficient to destroy the lymphocytes in the homografted organ and this may well be the mode of action resulting in prolonged function of some of these grafts. Such destruction of lymphocytes in the first graft had no apparent effect on a second graft. There is also the possibility that irradiation may have prolonged the function of the homografted kidney simply by its nonspecific, anti-inflammatory effect. Best results were observed when the radiation was started on the day of surgery and given regularly on alternate days thereafter. Local irradiation alone modified the homograft rejection sufficiently in some animals to allow prolonged functional survival up to 36 days. (BBB)

26038 SELECTIVE IRRADIATION OF LYMPH NODES AS A MEANS OF CONDITIONING FOR HOMOTRANSPLANTATION. S. P. Tilak and John M. Howard (Hahnemann Medical Coll., Philadelphia). Surg. Forum, 15: 160-1 (1964).

This study was designed to selectively and continuously irradiate part of the lymphopoietic system using ^{131}I-tagged (10 μC/1.5 ml) ethiodol. Ethiodol, injected directly into the lymphatics of the extremities, is absorbed by those lymph nodes with which it comes in contact and from which it gradually disappears over a period of weeks. Various doses of tagged ethiodol were injected intralymphatically into 20 dogs after recovery from splenectomy. In some animals, the thoracic duct was cannulated and ^{131}I escaping in the lymph was measured. Follow-up for eight months revealed the lymphocyte count, but not the neutrophile count, had fallen markedly for as long as four weeks. The involved lymph nodes, radiographically visible, showed a progressive reduction in size. Relatively large doses of irradiation were tolerated, with the animals apparently returning to normal within ~ six weeks after a single injection. Repetitive doses were found to have a cumulative effect. Histologic studies of the lymph nodes demonstrated destruction of the lymphocytes and germinal centers with replacement of these tissues by fibrous tissue. Lymphatic obstruction did not result. (BBB)

26039 SIGNIFICANCE OF LYMPHOCYTURIA IN RENAL HOMOGRAFT REJECTION. H. M. Kauffman, Richard J. Cleveland, H. M. Lee, and David M. Hume (Medical Coll. of Virginia, Richmond). Surg. Forum, 15: 168-70(1964).

The urinary sediment was sequentially examined in a group of treated and untreated mongrel dogs with renal homografts. Rare lymphocytes and tubular cells were observed in ten of 50 nontransplanted control animals. Significant lymphocyturia was observed in eight of ten bilaterally nephrectomized animals with control first set transplants. Hematuria secondary to serial needle biopsies prevented evaluation of the remaining two animals. The blood urea N (BUN) was less than 30 mg/100 ml in four of these eight animals when significant lymphocyturia occurred. A second group of animals received 200 R local x radiation to the graft every other day for six doses starting on the day of transplantation. Three of these animals had significant lymphocyturia on day six and one on day 11. Two animals did not demonstrate lymphocyturia. All animals had a BUN over 40 mg/100 ml at the time of lymphocyturia, the mean BUN being 51 mg/100 ml. Although all the kidneys in this group were ultimately rejected, histologic examination suggested an attenuation of the round cell infiltrate, and lymphocyturia appeared to occur later than in nontreated controls or failed to occur at all. Thus, significant lymphocyturia has been demonstrated during rejection of both control and radiation-treated dog renal homografts. Imuran-treated homografted animals with a cutaneous ureterostomy demonstrated large numbers of tubular cells in the host (nontransplanted kidney) urine. Wright-stained sections of rejected kidneys demonstrated that the infiltrating cells are primarily plasma cells and that lymphocytes can be found within tubular lumina. (BBB)

26040 THE ROLE OF HOST CONNECTIVE TISSUE IN CONTROLLING LOCAL TUMOR INVASION. Robert E. Madden and Charles M. Karpas (New York Medical Coll., New York). Surg. Forum, 15: 340-2(1964).

To assay the function of the host connective tissue in controlling the growth and local invasiveness of a primary tumor, an experimental model, the lathyritic animal, was employed in which connective tissue maturation was defective. A group of weanling Wistar rats was made lathyritic by the addition of 0.4% β-aminoproprionitrile (BAPN) to the diet. After four days on specific diet, 10^5 Walker 256 ascites cells were injected subcutaneously in the flank. Diet control animals were pair-fed but received no BAPN. Ad lib diet controls had no diet restriction or additive. To assess the possible factor of immune suppression by BAPN, a second group of lathyritic animals together with pair-fed and ad lib diet controls were tested having previously received 300 R total-body x irradiation. The results in nonirradiated weanlings showed early rapid tumor growth in the lathyritic animals. Tumors initially were larger than those of either pair-fed or ad lib rats and remained larger than those of pair-fed rats until killing. In the irradiated groups the results were similar. Both the tumors and animals were smaller in this series, probably due to radiation sickness. Lathyritic animals continued to have larger tumors than the equally starved pair-fed rats throughout, and the early growth advantage over ad lib feeding was only overcome near the end of the experiment. These data indicate the initial results are probably not due to any immune suppression by BAPN. In the adult animal groups, tumors appeared larger in lathyritics at first, but ultimately tumors of both pair-fed and ad lib equalled them in size. Since lathyrism is less easily established in adults where most of the connective tissue is mature, this gives further support to the concept that mature connective tissue by itself can act as a barrier to local tumor invasion. (BBB)

26041 COLOR MUTANTS OF SARCINA LUTEA INDUCED BY Co^{60} IRRADIATION. Kang Fan and I-Hung Pan (National Taiwan Univ., Taipei, Taiwan). Tai-Wan I Hsueh Hui Tsa Chih, 61: 826-33(Sept. 28, 1962).

Bacteria suspended in nutrient broth at pH 7.3 and 24°C were exposed to 800 to 48,000 R doses of ^{60}Co γ radiation, and methods were applied for selecting radiation-induced color mutants. At doses of 24,000 R and higher, mutants (giving white, pink, orange, light yellow, or orange colonies) were obtained. The spontaneous mutation rate of the parent yellow strain to other colored mutants was considered as zero. No color mutants were visible per 10^5 surviving bacterial colonies when the dose was below 24,000 R. There was no significant direct relation between color of the mutants and the doses, while the mutation efficiency was

roughly in proportion to the killing effect of the irradiation. There was no difference between parent strain and mutants as to size, shape, and convexity of the colonies cultivated on nutrient agar plates. Microscopically, they were also indistinguishable from one another after staining. Gram stain was positive for all strains. The color mutants obtained from irradiation showed no significant variation in activity of sugar fermentation. In attempts to demonstrate the connection between the parent strain and the color mutants in sensitivity to radiation, the mutants and the parent strain were irradiated at the dose of 48,000 R. The color mutants obtained at higher energy levels were relatively more radioresistant than the parent strain. Most of the color mutants were quite stable and showed no further color change after repeated and higher dose level irradiation before aging at room temperature. The penicillin-resistance test showed that there was no correlation between the induced color mutants and the drug resistance. (BBB)

26042 MODIFICATION OF THE RADIATION SENSITIVITY OF BARLEY WITH CHANGES IN THE ECOLOGICAL CONDITIONS. N. I. Nuzhdin, G. N. Shangin-Berezovskii, and N. A. Pastushenko-Strelets. Tr. Inst. Genet., Akad. Nauk SSSR, No. 31, 55-79(1964). (In Russian)

Studies were made on the growth and development of irradiated barley seeds (Jubilee and Kharkov 306). The data indicate that changing the environmental conditions produces changes in the radiosensitivity of barley seeds. This sensitivity is not connected directly with the damaging action of new conditions. Conditions for development of experimental types of barley were favorable in Odessa-Estonia and less favorable in Kel'bedzhar and Kedabek. Radiosensitivity of seeds was relatively high after sowing in Estonia and Kedabek and low after sowing in Odessa and Kel'bedzhar. Thus developmental conditions favorable for parents do not always show up positively in a resistance of the descendants to radiation. (P.C.H.)

26043 ENVIRONMENTAL CARCINOGENESIS. Paul Kotin (National Cancer Inst., Bethesda, Md.). Trans. Studies Coll. Physicians Phila., 32: 64-8(Oct. 1964).

This survey of environmental carcinogenesis is concerned with identification of carcinogenic hazards, elucidation of their mode of entry and mechanism of action in the host, and characterization of populations affected by them. The environmental carcinogens considered include biological, chemical, and physical agents (one of which is ionizing radiation). In only a few cases have laboratory experiments been helpful in obviously identifying carcinogenic hazards, as for example, aromatic amines in bladder cancer; hydrocarbons (cigarette smoke, air pollution) in lung cancer; and radiation in malignant lymphomas and lung cancer. The significance of less overt carcinogenic influences in the environment are still unknown and cancers of so-called spontaneous origin constitute the great majority. It is suggested that there is a need for integrated utilization of data obtained from epidemiological surveys, biometric studies, and laboratory investigations to increase their use in the appraisal of carcinogenic hazards to man. The site of action of a carcinogenic agent complicates the study of environmental carcinogenesis. While carcinogenic agents may affect the host at any site, resulting cancers can occur at distal as well as local sites. Cancers may develop at the site of initial tissue contact (skin-PAH), site of elective deposition or localization (marrow, bone-benzol and radium), site of metabolism and detoxification (liver-azo dyes, chlorinated hydrocarbons, amino-fluorenes), or site of excretion (urinary bladder-aromatic amines). These agents were established as carcinogenic by bioassay techniques which fail to duplicate the circumstances of human exposure either quantitatively or environmentally. Recent advances in laboratory carcinogenesis studies are mentioned, such as total-body exposure, in appropriately designed inhalation chambers, to chemical agents of known or suspected carcinogenic significance, including hydrocarbons, metals, natural products, and macromolecular synthetics. They can be aerosolized; animals can then be exposed to them in combination with known or suspected oncogenic and non-oncogenic viruses or in association with exposure to low-level radiation. The possibility of chemical and physical environmental carcinogens having their effect mediated through either ambient viruses or de novo formed viral agents is also considered. Protocol design, which should permit maximum possible quantitation of the relative contribution of each agent under experimental circumstances, is discussed and the following presented as examples of the questions that may be asked: (1) Do chemical agents mediate their carcinogenic effect through the action of viral agents? (2) Can the premature aging effect of low-level radiation be utilized as a model for determining the role of senescence in susceptibility to the action of carcinogenic agents? (3) Do each of these agents possess a threshold for response and can this be modified by the simultaneous exposure to subthreshold amounts of several environmental stimuli? It is is pointed out that from a chemical, physical, and biological viewpoint, a carcinogen-free environment is an impossibility. Since the rate of introduction of new agents into the environment is going to increase rather than decrease, such as radioactivity, the best approach to cancer control is through an understanding of the total response of the host as well as the response of individual cells, so that protection, if possible, can be accomplished either by establishing limits to exposure or, indeed, developing host buffering or protective measures. (BBB)

26044 APPLICATION OF IONIZING RADIATION IN EXPERIMENTS WITH GLADIOLUS. I. V. Dryagina. Vestn. Mosk. Univ., Ser. VI, Biol. Pochvoved., 19: No. 5, 46-56(1964). (In Russian)

The effect of single or continuous γ irradiation (0.15–75 kR) was studied in 14 varieties of gladiolus. These had different radiosensitivities. Sommerfreude and Vincent Van Gogh varieties were radioresistant, while Edith Eddy and Roma were radiosensitive. Bulbs of gladiolus were more resistant to continuous radiation in γ field than to single irradiation. Lethal dose of single irradiation of bulbs was 10 kR. Continuous irradiation in the period of one vegetation decreased proliferation in the next 2 growth periods. The irradiation disturbed physiological, and biochemical processes; it resulted in an increased as well as in a decreased activity of oxidation-reduction enzymes, photosynthesis, respiration, and other physiological properties. (C.E.S.)

26045 RELEASE OF INHIBITED TOBACCO MOSAIC VIRUS INFECTION BY ULTRAVIOLET IRRADIATION AS A FUNCTION OF TIME AND TEMPERATURE AFTER INOCULATION. Jia-Hsi Wu (Texas Technological Coll., Lubbock). Virology, 24: 441-5(Nov. 1964).

Experiments were designed to determine the efficiency of uv rescue of tobacco mosaic virus infection at different times after inoculation. The blocking strain used was VM, which induces minute lesions on Nicotiana glutinosa and which induces no sign of infection on Pinto bean. VM caused interference of Ul lesion production on both hosts. Inhibited Ul lesions were rescued with greatest efficiency immediately after inoculation. The efficiency of rescue progressively decreased as the time between inoculation and irradiation was extended. The efficiency of rescue of Ul infective centers on N. glutinosa remained constant for 2 hr and then decreased progressively until the blocked centers became totally resistant to uv rescue at 9 to 10 hr. A similar sequence was exhibited by VM-blocked Ul infective centers on Pinto bean. Development of resistance occurred much more rapidly at 30° than at 20°C in both Pinto bean and N. glutinosa. Potential Ul infective centers became resistant to uv rescue in 2 hr and were completely resistant 5 hr after inoculation of N. glutinosa leaves at 30°C. The data support the hypothesis that the particles that block Ul replication do not remain latent, but undergo the early events of infection which lead to virus biosynthesis. The observations suggest that where a susceptible site is presented with particles of two strains of TMV, particles of both strains may enter the site. However, only one of these particles directs the further course of in-

fection and becomes the progenitor of newly synthesized virus in the infective center. (TCO)

26046 THE EFFECTS OF X RADIATION ON OPHRYOTROCHA PUERILIS. A. L. Grierson and H. Querner (Institut fur Experimentelle Krebsforschung, Heidelberg). Z. Naturforsch., 20b: 350-5(Apr. 1965). (In German)

The polychaet, Ophryotrocha puerilis was exposed to radiation doses up to 100,000 R (3335 R/min). The effect of the radiation depends on the size of animal. In animals of 20 segments the LD 50/30 dose was about 50,000 R; in animals of 10 segments doses of 20,000 R and greater completely inhibited growth, and doses of 10,000 R inhibited the growth of smaller animals. Animals with 10 segments exhibited slight retardation of growth after 5,000 and 10,000 R, while the smaller animals did not grow after 10,000 R of radiation and had their growth significantly retarded by 5,000 R. Eggs laid by sexually mature females treated with 50,000 R failed to develop. After 20,000 and 10,000 R the eggs laid in the first 10 days did not develop but eggs exposed later were capable of development. Animals of 10 segments were fertile after 10,000 R but sterile after 20,000 R. Fractionation of the radiation dose decreased the mortality rate and, with a total dose of 20,000 R, allowed growth. Irradiation of eggs had an effect that was dependent on the age of the embryo. Up to 9 days 1000 R was lethal; from 10 days on 2000 R had no effect on development. Irradiation with 500 R showed no effect, while two 250 R increments of dose given 48 hours apart killed eggs 2–10 days old. (P.C.H.)

26047 EXPERIMENTAL INVESTIGATIONS ON THE ORIGIN OF CULTIVATED WHEAT. II. INDUCED MUTATIONS IN TRITICUM AESTIVUM SSP. MACHA (DEK. ET MEN) MAC KEY AND TRITICUM DICOCCUM SCHUBL. AND THEIR PHYLOGENETIC SIGNIFICANCE. H. Kuckuck and Ruth Peters (Technische Hochschule, Hanover). Z. Pflanzenzuecht., 51: 215-28(1964). (In German)

Seeds of T. aestivum ssp. macha, ssp. spelta, and T. dicoccum were treated with x rays in order to investigate the phylogenetic significance of the mutants that occurred. The principal mutants that occurred in T. aestivum ssp. macha were those showing a change in density of the ear, such as lax eared forms and dense eared forms which superficially resembled the compactum and squarehead types. An inflatum mutant was of particular phylogenetic interest in which the tendency to brittleness was reduced and which gave about 71% free-threshing kernels, whereas the original type had only 23% free-threshing kernels. In a cross between the squarehead wheat Heine VII with a compactum-like mutant of ssp. macha, transgressions in formation of the ear shape were observed. Extremely dense compactum and squarehead forms occurred. After irradiation of seeds of T. dicoccum mutations also occurred that affected the density of the ear and the degree of the investment of the kernels. It was established that dicoccum types with a loose investment have a high 1000 seed weight, whereas those with a very tight investment usually have a very low 1000 seed weight. One dicoccum mutant very closely resembled compactum wheat. The supposition mentioned elsewhere that the dense headed wheat of the neolithic lake dwellers, T. vulgare antiquorum, could have been a tetraploid, gains some support from this mutant. It is considered probable that T. carthlicum has arisen from T. dicoccum and that T. vulgare antiquorum represents a dense eared variety of T. carthlicum. From the results it was assumed that small mutations have played a great part in the origin of free-threshing tetraploid and hexaploid cultivated wheat. These findings do not exclude the possibility that mutations with larger effect and an introgressive hybridization may not have taken place in other cases. (P.C.H.)

26048 UV INACTIVATION AND THYMINE DIMERIZATION IN BACTERIOPHAGE ϕX. Charles N. David (California Inst. of Tech., Pasadena). Z. Vererbungsl., 95: 318-25(1964).

Thymine dimers (TT) were found in DNA following irradiation at 260 mμ. The quantum yield for dimer formation in bacteriophage ϕX (single-stranded DNA) is 0.013 dimers per quantum absorbed by a nucleotide. This is comparable to the quantum yield (0.019) for bacteriophage $T4V_1$ (double-stranded DNA), indicating there is no dependence of thymine dimerization on the nature of the irradiated DNA. In ϕX phage the number of TT per lethal hit is 0.34, compared with 4.8 for $T4V_1$. This demonstrates the existence of other, as yet unidentified, lethal photo-products in irradiated ϕX DNA. The discrepancy between DNA contents and uv sensitivities in $T4V_1$ and ϕX can not be due to the single-stranded nature of ϕX DNA. This can be seen by noting that the replicative form (the double-stranded form of ϕX) when plated under conditions of no biological reactivation, has a uv sensitivity about $\frac{1}{9}$ that of $T4V_1$ although it contains about $\frac{1}{40}$ the DNA. Furthermore, it was shown that this discrepancy cannot be due to differences in the quantum yield for thymine dimerization. Therefore, if TT are lethal, they must be subject to some kind of biological repair or bypass in $T4V_1$. Thus, lethal photoproducts, other than TT, necessary to explain ϕX inactivation, offer an alternative explanation for the discrepancy between the DNA contents and uv sensitivities of $T4V_1$ and ϕX. According to present measurements, these photoproducts must constitute at least 60% of the lethal lesions in ϕX. If these lesions, which are not repaired in ϕX, occurred in T4 DNA and were subject to reactivation mechanisms in this phage, the high resistance of $T4V_1$ to uv could be explained. (BBB)

26049 THE EVALUATION OF THE ESTROGENIC FUNCTIONAL ACTIVITY OF THE OVARY AFTER RADIUM TREATMENT. A. Zolcinski and J. Robaczynski (Obstetrical and Women's Clinic, Medical Academy, Krakow). Zentr. Gynaekol., 86: 203-5(Feb. 8, 1964). (In German)

The amount of Ra introduced into the cavum uteri was from 20 to 30 mg, and the castration dose amounted to from 1080 to 2250 mg-hr. Histological studies of the endometrium were carried out 4, 8, 24, and 48 weeks after irradiations of this type. These studies indicated that the cytological status of the uterus was altered for as long as 48 weeks after irradiation before it returned to normal again. The hormonal activity was altered in a manner that paralleled the histological changes observed. (H.G.D.)

26050 THE SUPPRESSION OF THE LETHAL ANAPHYLACTIC SHOCKS TO MICE BY WHOLE-BODY IRRADIATION. H. Finger (Justus-Liebig Universitat, Giessen, Ger.). Z. Naturforsch., 20b: 81(Jan. 1965). (In German)

Female mice (breed NMRI) were irradiated with a whole-body dose of 400 Rad before or after simultaneous intraperitoneal injection of Rinder serum albumin and inactivated pertussis germ suspension. The antibody formation was determined and the results showed that only when the injection occurred 36 hr before irradiation was the antibody formation suppressed. (J.S.R.)

26051 RESPIRATORY PATTERNS OF NORMAL AND IRRADIATED STRAIN L CELLS. M. Eunice Silkey. Thesis, Washington, D. C., Catholic Univ. of America, 1964. 52p.

An attempt was made to ascertain a system of conditions optimal for studying the energy metabolism of CUA 2, strain L fibroblasts, grown in monolayer, and to integrate into this system an investigation of the effects of ionizing radiations on growth and respiratory metabolism at several radiation dose levels and post-irradiation times. The cell concentrations required to maintain a constant rate of oxygen consumption (Q_{O_2}), the effect of pH on oxygen uptake, and the relative desirability of replacing serum with methyl cellulose, thiogel, or bovine albumin as a cushioning agent during respirometry were investigated. The Q_{O_2}, respiratory quotient (RQ), the lactic acid produced under aerobic conditions with and without glucose, and representative enzyme systems of the glycolytic and Krebs cycles were measured immediately after irradiation with doses of 1500 and 3000 R from a cobalt-60 source, and at 24, 48, and 72-hour post-irradiation times. Definite dose- and time-correlated inhibitions of aerobic glycolysis were observed while the glucose and lactic dehydrogenase systems maintained levels of activity above the activity of these systems

in the control cell at various post-irradiation times. Latent depressions of oxygen consumption as an effect of irradiation were evident when related to cell volume and were more marked when the medium lacked glucose. The respiratory quotient was variable with a suggestion that the 3000-R dose increased the RQ value. The investigated enzyme systems related to oxidative metabolism remained unimpaired. Evidence of the radiation depression of diphosphopyridine nucleotide (DPN) is presented. (Dissertation Abstr., 25: No. 6, Dec. 1964)

26052 A STUDY IN RABBITS CONCERNING THE EFFECTS OF X-IRRADIATION ON ANTIBODY PRODUCTION AND ADAPTATION FOR THE SECONDARY ANTIBODY RESPONSE TO SOME ANTIGENS OF INFECTIOUS AGENTS. Rjurik Golubjatnikov. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1964. 163p.

The effect of 550 R of whole-body x irradiation on antibody production and adaptation for the secondary antibody response (ASAR) to antigens of some infectious agents in rabbits was explored. Young albino rabbits were injected intravenously with 2 ml of "Quadrigen" vaccine (DTP· P); the vaccine contained aluminum phosphate-absorbed toxoids of diphtheria and tetanus and the antigens of Bordetella pertussis and poliovirus. A vaccine challenge on day 130 of the experiment, 65 days after the exposure to x rays, was employed to test the status of rabbits of various experimental groups in respect to their adaptation for a secondary antibody response (ASAR) to the antigens employed. It was found that an exposure to x rays 24 hours before the initial injection of vaccine blocked detectable antibody responses to all of the components of the DTP· P vaccine. Such treatment prevented the development of ASAR to diphtheria toxoid and to B. pertussis. In contrast, these rabbits developed ASAR to tetanus toxoid. An exposure to x rays 64 days after the initial vaccine injection reduced and delayed the secondary antibody response to the various components of the DTP· P vaccine injected on day 65. However, this injection of the vaccine on day 65 of the experiment restored or maintained ASAR to the toxoids of diphtheria and tetanus and to B. pertussis. An exposure to x rays 64 days after the initial vaccine injection impaired or abrogated ASAR to diphtheria toxoid and B. pertussis. ASAR to tetanus toxoid remained intact. The results with poliovirus were not conclusive. Experiments with a diphtheria toxoid monovaccine confirmed the above observations. (Dissertation Abstr., 25: No. 6, Dec. 1964)

26053 GENETIC VARIABILITY IN QUANTITATIVE CHARACTERS INDUCED BY THERMAL NEUTRON TREATMENT OF DIPLOID, TETRAPLOID AND HEXAPLOID OAT SEEDS. Carlos Luis Gonzalez. Thesis, Ames, Iowa, Iowa State Univ. of Science and Tech., 1964. 100p.

Seed lots from three oat species, Avena strigosa var. Saia, A. abysinica var. P.I. 193958, and A. sativa vars. Andrew, Burnett, and Pusa were irradiated with thermal neutrons to provide material for comparing the nature of mutations and the magnitude of genetic variability induced at different ploidy levels. In the M_3 generation forty lines from each irradiated population and a like number from a check population of each variety were grown in a split-split plot experiment with 3 replicates. In a few cases the population means were shifted significantly by the irradiation treatment and the variability was increased significantly in 18 of 35 variety-attribute combinations measured. Comparisons of the characteristics of the seed attribute frequency distribution from irradiation-derived and check populations showed that: (a) mutations occurring in diploid lines produced more discrete expression than those occurring at hexaploids, and (b) a larger portion of hexaploid than diploid lines carried mutations which showed some degree of expression. The presence and/or magnitude of genetic variability induced was influenced by the attribute being studied and the genotype treated. The genetic correlations indicated that the type of mutations present in the irradiation-derived hexaploid lines were similar to those induced in the diploid. Thermal neutron irradiation increased sterility in two of the treated populations, but there was no evidence that sterility contributed to the apparent induced variability. In general, the data support two points: (a) genotype may be more influential in determining the magnitude of induced genetic variability than is the ploidy level, and (b) the types of mutations induced in hexaploid and diploid species were similar. (A.G.W.)

26054 GENETIC EFFECTS OF CUMULATIVE IRRADIATION FOLLOWING X-RAY TREATMENT OF MALE RATS. Janet Coyle Hansen. Thesis, Madison, Wis., Univ. of Wisconsin, 1964. 140p.

An experiment in rats was conducted for the purpose of estimating the effects of x irradiation on the descendants of irradiated male ancestors. The lethal equivalent theory of Morton, Crow and Muller (1956) was applied with modifications to irradiated and control populations to estimate the average number of lethal equivalents induced per R per chromosome affecting sex ratio, litter size at birth, and postnatal survival. The genetic effects of irradiation on the quantitative traits: 3-week weight, 6-week weight, 69-day weight, 182-day weight, and age of vaginal opening were also studied. The males of the base population, generation 0, were randomly divided into a control group which received no irradiation and an irradiated group which received a dose of 450 R fractionated as follows: 100 R at 10 weeks of age, 150 R at 12 weeks of age and 200 R at 14 weeks of age. The irradiated and control males of generation 0 were randomly mated at 26 weeks of age to unirradiated females with the restriction that no parents had a grandparent in common. Each generation males in the irradiated line received 450 R as described and were mated to daughters of irradiated males by the restricted random mating system. Control males of each generation were mated to daughters of control males and these matings were contemporaneous to the irradiated line. Starting with generation 2, in each generation about one-third of the animals in the irradiated and control lines were sib mated in order to estimate the number of radiation-induced lethal and semilethal mutations. An analysis of the first four generations does not show significant genetic effects of irradiation expressed either as the average number of lethal equivalents affecting sex ratio, litter size at birth, and postnatal survival, or as the genetic effects of irradiation on body weights and age of vaginal opening. (Dissertation Abstr., 25: No. 6, Dec. 1964).

26055 CELLULAR RADIATION BIOLOGY. A Symposium Considering Radiation Effects in the Cell and Possible Implications for Cancer Therapy. A Collection of Papers Presented at the Eighteenth Annual Symposium on Fundamental Cancer Research, 1964. Baltimore, The Williams and Wilkins Co., 1965. 627p. (CONF-456). $16.00.

Thirty-eight papers are included; separate abstracts have been prepared for thirty-two. Six papers were abstracted previously in NSA; see 18:10894, 17472, 21701, 33402, and 35437 and 19:10896. (H.G.D)

For abstracts of individual papers see: 25829, 25830, 26056, 26057, 26058, 26059, 26060, 26061, 26062, 26063, 26064, 26065, 26066, 26067, 26068, 26069, 26070, 26071, 26072, 26073, 26074, 26075, 26076, 26077, 26150, 26151, 26152, 26153, 26154, 26155, 26208, and 26452.

26056 THE EFFECTS OF ULTRAVIOLET LIGHT ON THYMINE, URACIL, AND THEIR DERIVATIVES. H. E. Johns, M. L. Pearson, C. W. Helleiner, and D. M. Logan (Univ. Of Toronto and Dalhousie Univ., Halifax, Can.). p.29-51 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

In TpT, dUpU, and UpU, two isomeric dimers were produced in relative yields of about 5:1. It was not known whether one or both of these dimers are important biologically. Since Wulff (1963) showed in $T4v_1$ that about 4.8 dimers are formed per lethal hit, it may be that the dimer which appears in low yield is the biologically lethal one. The single hydrate is formed in both dUpU and UpU with about the same yield, but further experiments are required to look into the details of the photochemical reac-

tions in UpU. No hydrates were found in TpT. At short wavelengths (225 to 240 mμ) the yield of dimers in dUpU is about 2.5 times that in TpT, while at long wavelengths the two yields are about the same. The maximum amount of dimer which can be produced in TpT is very wavelength dependent. In dUpU the wavelength dependence is much less. In dUpU the ratio of the yield of hydrate to dimer at short wavelengths is about 0.5, while at long wavelengths it is about 3. The yields are equal at 265 mμ. In TpT an unidentified photoproduct TpT^4 with peak absorption at 325 mμ is produced irreversibly from TpT in low yield. This photo-product can be converted to another unidentified product TpT^3 upon irradiation at 313 mμ. TpT^3 can be converted back to TpT^4 by irradiation at 240 mμ. TpT^4 has a peak absorption at 325 mμ which TpT^3 lacks. TpT^3 behaves as if it were the dimer form of TpT^4. Photoproducts with peak absorption at 325 mμ were found in DNA by others, and may have biological significance. The effects of monochromatic uv on the ability of poly U to code for phenylalanine are being investigated. Preliminary data indicate that the loss of coding ability may be related to the total number of hydrates and dimers which are formed in poly U, and that the coding ability depends upon the number of unaffected uracils left in the chain. Monte Carlo calculations were performed on poly U chains to determine the number of hydrates and dimers which are produced as a function of dose. (auth)

26057 THE REPAIR OF ULTRAVIOLET PHOTOPRODUCTS IN DNA OF BACTERIA. Paul Howard-Flanders and Richard P. Boyce (Yale Univ., New Haven). p.52-63 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Radiosensitive mutants of Escherichia coli K12 were analyzed genetically. Highly radiosensitive females were mated with resistant male strains and uv-irradiated. Results showed there are three uvr (ultraviolet-resistant) gene loci and that all three are needed to repair uv-irradiated DNA. Repair mechanisms of uv-irradiated DNA were studied biochemically and a repair model is proposed. (H.G.D.)

26058 THE INACTIVATION OF DNA AND OTHER BIOLOGICAL MOLECULES BY IONIZING RADIATIONS. Franklin Hutchinson (Yale Univ., New Haven). p.86-99 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Work is reviewed on the action of ionizing radiations on the biological molecules of which the cell is compared. Emphasis is placed on: nucleic acid inactivation by simple target theory; inactivation of DNA viruses with radiation of high LET; and inactivation of transforming DNA. (H.M.G.)

26059 THE CONTRIBUTION OF WATER-FREE RADICALS TO THE X-RAY INACTIVATION OF BACTERIA. Ivar Johansen (Yale Univ., New Haven). p.103-6 "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Experiments were designed to determine whether the reactive species formed by radiolysis of water make any contribution to the lethal injuries sustained by irradiated cells. Escherichia coli B/r was x-irradiated in the presence of various substances (nitric oxide, sodium nitrate, ethanol, methanol, CO_2, sodium nitrate, and O_2) with known reactivities towards the water-free radicals. Results indicate that in regard to x-radioinduced lethal injury, neither hydrogen atoms nor solvated electrons make a significant contribution, while radical intermediates with properties similar to the hydroxyl radical are responsible for about half the effect. (H.M.G.)

26060 THE EFFECTS OF ULTRAVIOLET LIGHT ON NUCLEIC ACID CODING SYSTEMS. L. Grossman, J. Ono, and R. Wilson (Brandeis Univ., Waltham, Mass.). p.107-19 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

The effects of ultraviolet irradiation on the template properties of polycytidylic acid (poly C) catalyzed by RNA polymerase from Micrococcus lisodeikticus are described. The replication of poly C involves the polymerization of guanosine triphosphate (GTP) in the presence of Mn^{2+} and enzyme to yield the acid-soluble polyguanylic acid (poly G). In other experiments each of the remaining nucleoside triphosphates was added separately to the reaction mixture containing the labeled GTP, enzyme, and irradiated poly C. Only unlabeled ATP was capable of partially restoring the depressed incorporation of labeled GTP. (H.G.D.)

26061 ULTRAVIOLET LIGHT EFFECTS ON DEOXYRIBONUCLEIC ACID REPLICATION. C. O. Doudney (Univ. of Texas, Houston). p.120-41 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Studies of the kinetic aspects of recovery of DNA synthesis after uv exposure, utilizing measurement of DNA synthesis by chemical means and the density gradient analysis technique, are described. Control experiments on unirradiated cultures are presented which differentiate blockage of DNA synthesis with amino acid starvation from the uv-induced blockage of DNA synthesis. The data support the following general hypothesis: the recoverable block to DNA synthesis by uv at the lower dose levels is attributable to the production of damage in the bacterial DNA. DNA synthesis can proceed to the point of one of the damaged sites and then must stop. The duration of the delay in DNA synthesis depends upon the number of lesions induced in the DNA and thus is directly related to dose. When maximum delay in DNA synthesis is induced by uv, the DNA is damaged to the maximum possible extent for this recoverable type of damage. If DNA synthesis has been delayed to this extent by uv, repair of the DNA synthetic system is correlated with the doubling of cellular RNA. At lower doses of uv involving fewer lesions in the DNA chain, proportionately less RNA need be made for DNA synthesis to proceed. This suggests that repair is specifically at the sites of damage and that the RNA involved in repair need be formed only to the extent that there are lesions of this type. The possibility that the damage involved is the production of the thymine dimer and that RNA synthesis is involved in repair of this damage is discussed. The effects of acriflavine, caffeine, and certain dyes (crystal violet, methyl green) on DNA, RNA and protein synthesis, and survival, and mutation induction with uv-exposed bacteria are described. The results establish that these agents exert some action on uv-exposed cells which results in increased mutation frequency response and lethality as well as in blockage of DNA, RNA, and protein synthesis, while having little effect on non-uv-exposed cells. The results are consistent with a hypothesis in which the agents react with the uv-damaged site on the DNA, which is otherwise repairable, to prevent replication of DNA. The reaction would also prevent formation on the DNA template of the component of the RNA synthetic system (presumably the messenger RNA) necessary for total RNA synthesis. In irradiated cells, RNA doubles in the presence of these agents and then synthesis ceases; this suggests that gene action (messenger RNA formation) uncovers the DNA to the inhibitory action of the dyes on the damaged site, allowing one round of RNA formation before inactivation of the DNA template. Both the increased lethal and mutagenic effects are correlated with RNA synthesis in the culture. It is proposed that when the damaged site of the DNA interacts with the agents with RNA synthesis, the lethal, mutagenic, and metabolic effects are observed. An interpretation along the same lines is developed for mutation induced by uv (in the absence of the dyes). (auth)

26062 RADIOSENSITIVITY OF NUCLEAR ATP SYNTHESIS AND ITS RELATION TO INHIBITION OF MITOSIS. Herman M. Klouwen (Radiobiological Inst. TNO, Rijswijk, Netherlands). p.142-66 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

In order to evaluate alternative mechanisms of radiosensitivity of nuclear ATP synthesis (interphase death, and inhibition of mitosis), normal and neoplastic tissues were studied in mice and rats. Nuclear ATP synthesis could be demonstrated only in a restricted number of cell types

(thymus, spleen, and lymphosarcomas). The radiosensitivity of nuclear ATP synthesis could be detected only in thymus and lymphatic tissues within one hour of whole-body irradiation with low doses (100 to 500 R). In different lymphosarcomas only 24 hrs after a radiation dose of at least 1000 R, an inhibition of nuclear phosphorylation was detected. It was concluded that in cells that undergo interphase death, early inhibition of nuclear ATP synthesis is observed. In cells that undergo mitotic death, inhibition of nuclear ATP synthesis cannot be demonstrated before 12 to 24 hrs after 1000 R. In lymphosarcoma cells radiation effects other than inhibition of nuclear ATP synthesis can cause inhibition of mitosis. It was evident that the energy production sites in cells show important variations in radiosensitivity. In cells in which all sites are severely damaged, interphase death is the major radiation effect. (H.G.D.)

26063 RADIATION EFFECTS AS MEASURED BY CHROMOSOME DAMAGE. Sheldon Wolff (Oak Ridge National Lab., Tenn.). p.167-83 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Low doses of radiation kill cells. At these doses the effect of radiation is most likely on the nucleus. One good parameter of nuclear damage is the production of chromosome aberrations, although, as yet, a one-to-one kinetic relation between the production of any given chromosome aberrations as indicators of radiation-induced cell damage and of their value in studies in basic cellular radiobiology, one must be cautious in interpreting experiments on chromatid (as opposed to chromosome) aberrations. The reason for this is that the parts of the cell cycle in which chromatid aberrations are induced are not uniformly sensitive to x rays, different yields are obtained in cells irradiated in the various portions of the cell cycle. If any adjunctive treatment, other radiation, higher doses of the same radiation, or chemical compounds, induces changes in the mitotic cycle, one would make comparisons at metaphase between cells that came from different parts of the cell cycle. (auth)

26064 CRITICAL STRUCTURES OTHER THAN DNA AS SITES FOR PRIMARY LESIONS OF CELL DEATH INDUCED BY IONIZING RADIATIONS. P. Alexander, C. J. Dean, L. D. G. Hamilton, J. T. Lett, and G. Parkins (Royal Cancer Hospital, London). p.241-63 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

The question of whether radiochemical changes constitute the principal primary lesion for mitotic cell death following irradiation with x rays is considered. Examples are given where variations in the radiosensitivity of mammalian cells can be attributed to postirradiation recovery phenomena and a comparison of cells having different D_0 cannot be used to investigate the primary lesion. It is interesting that tetraploid and diploid mutants of leukemia cells had the same radiosensitivity. Some very radioresistant Micrococci have DNA with base ratios which are very similar to those of the most sensitive microorganisms. The presence of intracellular protective agents does not seem to explain the radioresistance of the Micrococci. Radiochemical experiments show that DNA is not rendered more susceptible to damage (measured physicochemically) if thymine is replaced by bromouracil (BU) when irradiated in solution or within the cell. Sensitization of cells approaches a limit with increasing BU incorporation, and a radiosensitive mutant is sensitized much less. Sensitization by BU seems to be a phenomenon acting primarily at the level of postirradiation recovery. The effect of irradiation on the molecular weight of DNA extracted from cells immediately after irradiation is the same whether the cells were protected by anoxia, glycerol, or cysteamine or were exposed under normal aerobic conditions. Under conditions in which microorganisms are sensitized by iodoacetamide or protected by cysteamine, neither of these substances penetrates into the interior of the cell. Within 15 minutes of irradiation of leukemia cells, changes in nuclear ribonucleic acid (RNA) can be detected which might be caused by a release of nuclear RNase. (auth)

26065 THE STUDY OF RADIOSENSITIVE STRUCTURES WITH LOW-VOLTAGE ELECTRON BEAMS. Arthur Cole (Univ. of Texas, Houston). p.267-71 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Studies are reviewed in which monoenergetic electron beams of 0.5 to 150 kev were used to irradiate cellular monolayers on membrane filters. Wet, dry, oxygenated, anoxic, and BUdR treatment conditions were utilized in various experiments with T2 bacteriophage, Streptomyces spores, E. coli cells, haploid yeast cells, and mouse fibroblast cells. Tabulated results were consistent with the supposition that radiosensitive structures appear to be in a thin shell located at a specific depth below the cell surface. (H.G.D.)

26066 INTERACTIONS OF MODIFYING TREATMENTS AND THE LIGHT THEY THROW ON TARGETS FOR CELL DEATH. Tikvah Alper (Hammersmith Hospital, London). p.272-85 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

The value of radiation modifying treatments in identifying mechanisms of radiation-tissue interactions is discussed in view of the oxygen effect, which can be used to show that there is more than one type of radiation damage. Methods for calculating radiosensitivity and oxygen enhancement ratios are discussed. (H.G.D.)

26067 SOME PHYSICOCHEMICAL BASES OF RADIATION SENSITIVITY IN CELLS. E. L. Powers (Argonne National Lab., Ill.). p.286-304 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Types of radiation damage recognized in the dry spore or vegetative bacterial cell include: formation of dry cell free radicals that must react with oxygen to become biologically effective; a radical effect characterized by immediacy of action; and the oxygen independent damage. Properties of the various types of damage are discussed and related to more general problems in radiobiology. Experiments with the effects of amount and kind of water on the various components of radiation damage are described. (H.G.D.)

26068 RADIOSENSITIVITY AND RECOVERY OF RADIATION DAMAGE IN RELATION TO THE CELL CYCLE. William C. Dewey and Ronald M. Humphrey (Univ. of Texas, Houston). p.340-75 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Variations in sensitivity to ionizing radiation during the cell cycle were studied in vitro by autoradiographic techniques. Regarding cell lethality and chromosomal damage observed at anaphase in a mouse L fibroblast cell, the S phase was the most radiosensitive, the G_1 the most radioresistant, and the G_2 was intermediate in sensitivity. For chromosomal damage observed at metaphase, however, the G_2 phase was more radiosensitive than the S phase. For cell lethality and for chromosomal damage observed either at anaphase or metaphase in a Chinese hamster cell, the G_2 phase was more radiosensitive than the S phase, which had about the same sensitivity as the G_1 phase. Also, for chromosomal damage in the hamster cell, no difference in radiosensitivity could be detected between the early and late S phases. Restitution of radiation damage during the cell cycle was also studied. Restitution of sublethal damage in the mouse L cell occurred over a period of two to three hours in both the S and G_1 phases. Insufficient data were available to demonstrate clearly recovery in the G_2 phase. In the Chinese hamster cells, both the restitution of chromosomal damage and the repair of sublethal damage occurred during S phase over a two- to three-hour interval. Although the repair of sublethal damage was not studied during the G_2 phase, no restitution of chromosomal damage could be demonstrated over a one-hour interval during the G_2 phase. During the G_1 phase the reunion of chromosomal breaks appeared to occur over a five- to ten-minute interval, but no repair of sublethal damage could be demonstrated during this interval. The cyclic nature of recovery curves for sublethal damage, which increase to a maximum and then decrease to a minimum, was explained on the basis of surviving cells progressing

through the cell cycle into a more radiosensitive phase. This radiosensitive phase may be either S or G_2, e.g., S for mouse L cells and G_2 for Chinese hamster cells. (auth)

26069 X-RAY SENSITIVITY CHANGES DURING THE DIVISION CYCLE OF HeLa S3 CELLS AND ANOMALOUS SURVIVAL KINETICS OF DEVELOPING MICROCOLONIES. L. J. Tolmach, Toyozo Terasima, and Robert A. Phillips (Washington Univ., St. Louis). p.376-96 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Observationally distinct responses of synchronized HeLa S3 populations to 220-kev x-ray exposure that were examined include: changes in proliferative patterns; effects on DNA synthesis; and loss of reproductive viability as measured by colony formation. Cell proliferation, measured by repeated counting of cells in specified microscopic fields revealed a radioinduced delay in division, increasing as cells were irradiated progressively later in the cycle. To study the effects of x irradiation on patterns of DNA synthesis, synchronous cells were irradiated during the G_1 or S phases. Radioautography with tritiated thymidine was used to determine the effect produced by 300 rads on the passage of cells from G_1 into S, on the rate of DNA synthesis, and on the duration of the S period. Irradiation of mitotic cells scarcely affected the passage from G_1 to S, but measurably decreased the rate of synthesis and prolonged the S period. When cells were irradiated in the G_1 phase, no measurable delay in the inception of DNA synthesis was noted. Irradiation of cells already synthesizing DNA caused a decline in rate and a prolongation of the S period. Studies on reproductive viability indicated: that the fluctuations in radiosensitivity of HeLa S3 cells are correlated with the DNA cycle; that sensitivity changes continuously throughout at least most of the cycle; that the end of G_1 is the most sensitive point during interphase; and that the subsequent decrease in sensitivity is dependent on DNA synthesis. (H.G.D.)

26070 EFFECT OF X RAYS ON INITIATION OF DNA REPLICATION IN VIVO. Daniel Billen (Univ. of Texas, Houston). p.397-403 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Results of experiments with a multiauxotrophic, thymine-requiring strain of E. coli used to study the effects of ionizing radiation on the initiation of the subsequent cycle of chromosome replication are presented. It was shown that if DNA synthesis were allowed to go to completion in the absence of the required amino acids, a dose of 10,000 R was sufficient to increase the lag normally seen in the unirradiated control cells following amino acid starvation. Metabolic states contributing to this effect are discussed. From a study undertaken to determine the availability of the kinases needed to phosphorylate thymidine and the deoxyribosides of cytosine, adenine, and guanine to their respective triphosphates; it was concluded that the effects of ionizing radiation at the dose required to kill 90 to 99 percent of the population could not be accounted for by an insufficient supply of the enzymes responsible for providing the deoxyribonucleotide triphosphates and for subsequent conversion of the substrates into the DNA polymer. (H.G.D.)

26071 CHROMOSOME ABERRATIONS INDUCED BY INCORPORATION OF TRITIATED THYMIDINE. T. C. Hsu and Maria T. Zenzes (Univ. of Texas, Houston). p.404-10 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Tritiated thymidine was used to study the correlation between the site of incorporation and the site of chromosome damage in a diploid Chinese hamster cell strain in which DNA replication is asynchronous. Frequency of aberrations increased with increased tritiated thymidine and duration tritium treatment. However, the percentage of exchanges increased more rapidly with the increase of duration than with that of dosage. Although incorporation of tritiated thymidine did not always induce chromosome damage, a high frequency of damage was seen to locate at the sites of radioactivity. Results do not deny the possibility that chromosome aberrations may be indirectly induced, but clearly indicate that the sites of incorporation are the primary targets of the β particles. (H.G.D.)

26072 MATHEMATICAL MODELS OF THE RECOVERY OF MAMMALIAN CELLS FROM RADIATION INJURY, WITH RESPECT TO CHANGES IN RADIOSENSITIVITY. G. M. Hahn, J. R. Boen, R. G. Miller, S. F. Boyle, and R. F. Kallman (Stanford Univ., Palo Alto, Calif.). p.411-17 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

A phenomenological model was constructed to elucidate phenomena involved in the survival of x-irradiated mammalian cells. The cells were represented mathematically by a vector composed of the subpopulations. Operators were constructed which affected transformations corresponding to specific events. Compound events were described by the sequential application of individual operators. It is concluded that the predictions from the model are in qualitative agreement with observation. The computer results did not show the exponential envelope, or trend, of the recuperation curves seen experimentally. It may be inferred, therefore, that the radiation-sensitivity changes, which occur during recuperation after a first dose, reflect two kinds of events: shifts in the proportions of cell states which constitute the normal population; and a true repair process taking place intracellularly in cells which have received a sublethal injury. (H.G.D.)

26073 SURVIVAL AND RECOVERY IN X-IRRADIATED SYNCHRONIZED CHINESE HAMSTER CELLS. W. K. Sinclair and R. A. Morton (Argonne National Lab., Ill.). p.418-22 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Chinese hamster cells were pulse-labeled with tritiated thymidine preceding exposure to various doses of x radiation. Survival after x-irradiation varied with cell age and was greatest (over two decades at least) for cells in the S period. Recovery following a dose of x rays was distinguished from the changing response resulting from varying cell age by the two-dose fractionation technique and was shown to be quite definite for cells in S. (H.G.D.)

26074 RADIATION SENSITIVITY THROUGHOUT THE CELL CYCLE AND ITS RELATIONSHIP TO RECOVERY. G. F. Whitmore, S. Gulyas, and J. Botond (Univ. of Toronto and Ontario Cancer Inst., Toronto). p.423-41 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Synchronized populations of L cells were used to examine the effect of age or position in the cell cycle on radiation response to acute exposures and on the recovery of cells between fractionated doses of radiation. Duration of the various phases was also determined. Evidence suggests that the kinetics of cellular recovery in a two-dose fractionation experiment is the result of two processes: a true repair of sublethal damage, and the migration of cells through different ages and into different radiation response states. The degree of recovery which will be seen in any population will depend upon the age distribution of the population at the time of irradiation. (H.G.D.)

26075 EFFECTS OF SINGLE AND REPEATED LOW DOSES OF IONIZING RADIATIONS ON THE PROLIFERATIVE CAPACITY OF HUMAN CELLS IN CULTURE. G. W. Barendsen (Radiobiological Inst. TNO, Rijswijk, Nederlands). p.469-73 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Theoretical survival curves of single and repeated exposure of human cell cultures to x rays and ^{210}Po alpha particles are considered in terms of multievent models and multitarget models. Factors influencing variations in radiosensitivity of human tumors are discussed. (H.G.D.)

26076 RADIATION RESPONSE OF C3H MOUSE MAMMARY CARCINOMA EVALUATED IN TERMS OF CELLULAR RADIATION SENSITIVITY. H. D. Suit, R. J. Shalek, and R. Wette (Univ. of Texas, Houston). p.514-30 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Cellular radiosensivity of the C3H mouse mammary carcinoma cell was investigated by analysis of 16 radiation dose-response experiments using as the end point the permanent local control of tumor. Pertinent aspects of the experimental design were: all radiations were given as single doses and under conditions of local tissue anoxia; the distribution of radiation dose throughout the tumor was uniform ±4 per cent; and the likelihood of an immunologic reaction by the host against the tumor negligible. The tumors employed in these studies have been in the range of 0.16 mm^3 to 1,000 mm^3 at the time of irradiation; these were either spontaneous carcinomas or early generation isotransplants. Radiation response (proportion of local cure at each dose level for each tumor volume used) was assessed at 10-day intervals from day 30 to ≈ 200 after treatment. These results have been used to compute a TCD_{50} (tumor dose that controls half of the tumors) at each time interval. The plot of TCD_{50} against time after irradiation showed that the TCD_{50} approached an asymptote at 80 to 150 days. A plot of $\log_{10}$ tumor volume, at the time of irradiation, against TCD_{50} yielded a scatter of points within the area that would be enclosed by curves predicted on these considerations: survival fraction of tumor cells $S = 1-(1-e^{-D/D_{37}})^N$, a recurrence always develops if one or more cells survive; and radiosensitivity of the anoxic mouse mammary carcinoma cell (D_{37} = 300 to 325 Rads and N = 1 to 6). The data are interpreted as being consistent with the proposal that the cells of this tumor tissue respond to radiation randomly and on the basis of individual cellular radiosensitivity; that is, the results do not indicate a tissue effect on cellular radiosensitivity, tumor bed effect on tumor curability, or nonspecific host-tumor effect. They also indicate in this animal tumor system that cells which survive in a reproductive sense also have a high probability of surviving metabolically long enough to proliferate and produce a recurrence of tumor. (auth)

26077 DOSE DETERMINATION FOR X IRRADIATION OF MOUSE TUMORS. James Nunnally, Ralph Worsnop, and Robert J. Shalek (Univ. of Texas, Houston). p.531-8 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Minimum doses were determined for mouse tumors so that radiation response in terms of cellular radiosensitivity might be assessed. Measurements with a Victoreen chamber were compared to those made with a Fricke chemical dosimeter. The average dose measured by the chemical dosimeter was 4 percent higher than the average dose calculated by the ionization method. Tumor doses are estimated to have a standard deviation of about 5 percent in individual exposures due to errors from all causes. (H.G.D.)

26078 RESPONSE OF THE NERVOUS SYSTEM TO IONIZING RADIATION, SECOND INTERNATIONAL SYMPOSIUM HELD AT THE UNIVERSITY OF CALIFORNIA, LOS ANGELES. Thomas J. Haley and Ray S. Snider, eds., Boston, Little, Brown and Company, 1964. 769p. $18.50 (CONF-235)

Forty papers are included; separate abstracts were prepared for 34. Six papers on cytochemistry of delayed radionecrosis of the murine spinal cord, bioelectric sensitivity to irradiation of the retina and visual pathways, lipid metabolism in acute radiation injury in brain, studies of brain lysosomes, and delayed effects of x irradiation on the CNS of the monkey were previously abstracted in NSA as 17: 40545, 18: 3500, 8102, and 23236, and 19: 19610 and 19611. (P.C.H.)

For abstracts of individual papers see: 25889, 25890, 26079, 26080, 26081, 26082, 26083, 26084, 26085, 26086, 26087, 26088, 26089, 26090, 26091, 26092, 26093, 26094, 26095, 26096, 26097, 26098, 26099, 26100, 26101, 26102, 26103, 26104, 26105, 26106, 26107, 26108, 26209, and 26210.

26079 TISSUE REACTIONS OF THE HUMAN FRONTAL WHITE MATTER TO GAMMA RADIATION. Orville T. Bailey (Univ. of Illinois Coll. of Medicine, Chicago), John S. Woodard, and Tracy J. Putnam. p.3-18 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

The zones of reaction to ^{60}Co inserted into the frontal white matter of 2 patients were studied and compared with the lesions produced in animals by sources of gamma radiation. One patient survived $2^2/_3$ years, the other $3^5/_{12}$ years. Striking resemblances were found between the lesions in the human and the experimental material. Part of the lesion due to ^{60}Co radiation is due to vascular lesions with resultant infarction. Much more of it was found to be the result of differential effects on various cellular elements in the area of injury. Alterations in the pattern of repair sequences resulting from recovery of different reacting cells in a specific order was evidence for the differential effect of gamma radiation on the central nervous system. This differential effect also determined the characteristics of repair in areas of radiation repair that make them different from repair resulting from other types of injury in similar tissues. (auth)

26080 ELECTRON MICROSCOPY OF RADIATION-INDUCED LAMINAR LESIONS IN THE CEREBRAL CORTEX OF THE RAT. David S. Maxwell (Univ. of California, Los Angeles and Veterans Administration Hospital, Long Beach, Calif.) and Lawrence Kruger. p.54-83 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Electron microscopic studies were made on laminar lesions induced in the cerebral cortex of female rats by alpha particles 6000 and 9000 Rad. The results are discussed. In and above the lesion area from five days through the third week after irradiation, small blood vessels showed a reactive change. However, at the dosage levels employed, the integrity of the vessel walls was not threatened, and extensive extravasation did not occur. Five days after 9000 Rad irradiation, the astrocytes above and through the lesion area were markedly altered from the normal. The cytoplasm of these cells displayed a striking increase in glycogen content. This increase was noted only in the lesion area in the group irradiated with 6000 Rad and provided a useful index of lesion location as the section was scanned in the electron microscope. Nissl-stained material showed an absence of neurons in the zone of the laminar lesion after a few weeks. Therefore, many of the neurons in the zone of maximal ionization are destined to disappear, and abnormal appearances may be assumed to be due to degeneration. There was no evidence that the dendrites of cortical neurons are extensively disrupted since they were clearly present within the laminar lesion at all stages studied to date. (P.C.H.)

26081 ANATOMICAL AND FUNCTIONAL STUDIES OF THE CEREBRAL CORTEX BY MEANS OF LAMINAR DESTRUCTION WITH IONIZING RADIATION. Lawrence Kruger (Univ. of California, Los Angeles and Veterans Administration Hospital, Long Beach, Calif.) and Carmine D. Clemente. p.84-104 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Anatomical and functional studies were made on lesions of the cerebral cortex in slightly over 300 animals: rats, rabbits, cats, and monkeys. Irradiations were performed with alpha particles at 10 to 12 Mev in the dose range of 4000 to 30,000 Rad. The threshold for production of a laminar lesion with 48 Mev alpha particles (12 Mev per nucleon) was found to lie within a range of 5000 to 6000 Rad (surface dose). The results indicated that, by proper selection of radiation dose, three types of cortical preparations can consistently be obtained for physiological study: cortex with an aneuronal lamina, whose width can be varied from 50 to 120 μ (in paraffin sections) and which can be placed at any given depth in the cortex; cortex with a thin artificial zonal lamina above any given cellular layer; and cortex with complete and accurate destruction to a given depth, without a fiber layer at the surface. Each type is discussed separately. (P.C.H.)

26082 RADIATION AND THE EAR. George Kelemen (Harvard Medical School, and Massachusetts Eye and Ear

Infirmary, Boston). p.127-45 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Young rats were exposed to whole-body radiation between 100 and 3000 R, 85 by x ray and 45 by cobalt; 15 served as controls. Sectional series of celloidin-embedded temporal bones were examined under the microscope. To avoid the influence of nonexperimental pathological changes (a factor of great consequence), the findings were tabulated on the basis of infection-free material, with some data utilized (outside the tabulation) from cases showing disease independent from the experiment. Hemorrhage – primary by direct, acute extravasation and secondary by damaged vessels giving way – was clearly the leading effect of radiation. The tympanic membrane, the mucous membrane lining of the middle ear including the ossicles, showed engorgement with extravasation. Sometimes, the bone suffered by participation of the periosteum in the general process. The inner ear was conspicuous by remaining, in many instances, intact next to a heavily damaged tympanic cavity. Damage, here, manifested itself in vascular phenomena: perilymphatic edema with compression of the endolymphatic space in the vestibular part, and destruction of the elements of the cochlear duct, with the exception of the remarkably resistant tectorial membrane, by hemorrhage from the stria vascularis. The basilar and the Reissner membranes remained intact, the latter being without exception in its normal position. Most conspicuous was destruction of the papilla of Corti and surrounding elements in its vicinity, whereas cristae, including their cupulae, and maculae proved to be practically immune to radiation effects in the dosages applied. Although in a number of cases the organ of Corti was destroyed while next to intact vestibular end organs, in other cases it was found intact next to massive infection in the adjacent middle ear. In different cochlear turns the organ of Corti showed different degrees of disintegration, the apical turn generally containing the organ with least damage. (P.C.H.)

26083 EFFECTS OF IONIZING RADIATION ON THE RAT EMBRYO CENTRAL NERVOUS SYSTEM AT THE CELLULAR AND ULTRACELLULAR LEVELS. L. Roizin (New York State Psychiatric Inst. and Columbia Univ., New York), R. Rugh, and M. A. Kaufman. p.146-74 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Studies were made on the embryonal rat central nervous system x irradiated in utero at 9.5 days of gestation (g.d) with 100 R (group 1) and 150 R (group 2). Alterations of individual or small groups of neuroectodermal cells involving variations in their staining properties, structure, density of distribution, and alignment were found in group 1 at 9.5 g.d. + 1 to 4 hr, and 13.5, 15.5, and 17.5 g.d. Diffuse decrease in the size of the central nervous system was observed in the same group at 11.5 to 17.5 and 21.5 g.d. Other abnormalities observed are also described. Many of the abnormalities occurred together in the same animal or animals. However, the more florid malformations in general tended to be rather sharply restricted on one of the ages examined. Electron microscopic examinations are described in detail. (P.C.H.)

26084 OBSERVATIONS ON NEW BORN RAT DORSAL ROOT GANGLIA IN VITRO FOLLOWING GAMMA IRRADIATION. C. M. Pomerat (Pasadena Foundation for Medical Research, Calif.), D. E. Rounds, C. W. Raiborn, Jr., and T. D. Pollard. p.175-200 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Newborn rats were exposed to gamma radiation at dosage ranging from 500 to 100,000 R. Unirradiated litter mates served as controls. Immediately after treatment, dorsal root ganglia were explanted into Rose chambers and maintained in culture for periods up to 21 days. High-energy gamma radiation produced little observable effect on neutrons. Active growth-cone migration was observed from regenerating neurons in ganglia 18 days after receiving 60,000 R. Neuronal nuclear rotation was recorded 25 days after 18,000 R. In a preliminary study, however, supravital staining with chlorpromazine, as a fluorescent dye, suggested that redistribution of the drug in the cytoplasm of neurons exposed to 1000 R was delayed. Schwann cells were observed to undergo rhythmic pulsations approximately every 5 to 7 minutes. Radiation of dorsal root ganglia with either 6000 or 20,000 R produced no significant change in the modal value of the contraction frequency. Some surviving Schwann and mesenchymal cells showed multinucleation, cytoplasmic vacuolation, and cellular enlargement following radiation. Hypertrophy was considered to be the result of teloreduplication as evidenced by multinucleation or altered membrane permeability as suggested by vacuolation. Treatment of unirradiated cultures with 5-fluorouracil resulted in Schwann cell swelling within 3 days. By analogy, radiation may produce enlargement as a result of an inhibition of DNA replication during continuous RNA and protein synthesis. The data suggest that neurons are extraordinarily radioresistant when they are independent of a blood supply, as seen in tissue culture. Radiation injury to the nervous system, therefore, may be mediated through damage to the circulatory system or to the supporting glial elements, or to both. (auth)

26085 RADIATION EFFECTS ON THE MEMBRANES OF PLANT AND ANIMAL CELLS. O. Hug (Universitat, Munich), H. Esch, and H. Miltenburger. p.213-20 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

X radiation effects on the membranes of cells in Nitella were studied. Resting and action potentials of plant cells were found to be basically the same as those in animal cells with the exception that the role of the electrolytes is somewhat different. Action potentials in Nitella had a duration of seconds compared to milliseconds in animal cells. The resting potential changed immediately with the beginning of irradiation and had a strong dependence on dose rate. A state of hyperpolarization observable at low doses was turned into a depolarization at higher doses. After irradiation electrically induced action potentials showed changes in form, mainly due to a prolonged repolarization. However, complete recovery occurred in the course of hours. Radiosensitivity depended on the functional state of the cell, as revealed by periodic changes of dark and light. (P.C.H.)

26086 RELATIVE SENSITIVITY OF ISOLATED NERVES TO Co^{60} GAMMA RAYS. C. S. Bachofer (Univ. of Notre Dame, Ind.), M. E. Gautereaux, and S. M. Kaack. p.221-42 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

In order to determine the relative sensitivity of different nerves to cobalt-60 gamma radiation under comparable conditions, a series of experiments was conducted which utilized 23 different nerve and muscle preparations from selected types of animals. Over 200 experiments were conducted. Action potentials of nerves were recorded oscillographically and isometric contractions of muscles were recorded by means of strain gages. After a period of stabilization, each preparation was irradiated continuously until it failed to respond to electrical stimulation. Records of activity were made before and during irradiation. Many striking differences in the sensitivity of nerves to radiation were noted. The same type of nerve, for example, was found to have different sensitivities in different animals, and different types of nerves in the same animal possessed different sensitivities. As an example of the former, more than twice the dose of gamma radiation was required to block conduction in the sciatic nerve of Blanding's turtle as in the sciatic nerve of the leopard frog. As an example of the latter, almost twice the dose of gamma radiation was required to block conduction in the caudal nerve of the white rat as in the sciatic nerve of the same animal. Synaptic transmission, usually considered to be quite sensitive to radiation, was found to be extremely resistant in the turtles investigated. C fibers of the postganglionic nerve trunk of the superior cervical ganglion of the turtle were among the most radioresistant of all nerves studied. A comparison of certain factors

often assumed to be of importance in determining radiosensitivity, for example, myelination of the nerve fiber or rate of metabolism of the tissue, showed no correlation with the results. From the action potentials of single giant fibers of the earthworm, a pattern of radiation effects on various ionic movements involved in the action potential was deduced. A mechanism of action of ionizing radiation on nerves is postulated to explain the results observed. (auth)

26087 EFFECTS OF X-IRRADIATION ON Na^{22} EFFLUX IN ISOLATED NERVES. James R. Lott and C. H. Yang (North Texas State Univ., Denton). p.271-8 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

A method was introduced by which one can follow the flux of isotopes across isolated nerve membranes during x irradiation. Isolated ventral caudal nerves of rats were loaded with Ringer's solution made radioactive with ^{22}Na. The loaded nerves were placed in a chamber through which was passed normal Ringer's solution. The effluent solution was monitored for its radioactivity continuously before, during, and after x irradiation. Some nerves were x irradiated at a calculated dose of 6.6 kR per minute for 15 minutes. Another group received 15 minutes of irradiation in three 5-minute periods. The data clearly indicate an immediate increase in ^{22}Na efflux from the loaded nerves during x irradiation and thereby demonstrate a direct change in ion permeability of the membranes due to x irradiation. The enhancement of ^{22}Na efflux was noted to occur within 1 minute following application of the x irradiation, which indicates an effect at dosages less than 6 kR. The observed increase in ^{22}Na efflux sustained, in most cases, during the irradiation periods and then fell to control levels following irradiation. An attempt was made to correlate the changes in ^{22}Na efflux during x irradiation with the reported changes in electrical properties of x irradiated nerves. (auth)

26088 ACUTE RADIATION EFFECTS ON MAMMALIAN SYNAPTIC ACTIVITIES. Makoto Sato and George Austin (Univ. of Oregon Medical School, Portland). p.279-89 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

The exposed spinal cord was irradiated with x rays during intracellular recordings. Using microelectrodes filled with potassium citrate, intracellular recordings were made from single motoneurons in the cat spinal cord during antidromic and orthodromic activation. The membrane resting potentials (MRP) were continuously recorded on a polygraph throughout the entire experiment. Monosynaptic excitatory postsynaptic potentials (EPSP) and isolated inhibitory postsynaptic potentials (IPSP) were intracellularly recorded from the biceps-semitendinosus motoneurons by stimulating biceps-semitendinosus nerve and quadriceps nerve, respectively. The monosynaptic EPSP showed a significant increase in amplitude and duration following exposure to 600 R, whereas the IPSP did not change within this dose range. The polysynaptic EPSP and IPSP were recorded during the stimulation of segmental dorsal root or dorsal roots one to two segments cephalad from the recording level. The polysynaptic EPSP was more markedly augmented by irradiation than the monosynaptic EPSP, while the polysynaptic IPSP showed only a slight increase after 9 kR irradiation. Antidromic intracellular spike responses (ISR) were recorded from the same motoneurons in parallel with recording the synaptic activities following exposure to the radiation. The amplitude of the ISR increased as much as 10 to 20 mv following 9 to 15 kR irradiation, while the duration of the ISR decreased 10 to 20% of the control values. Afterhyperpolarization of the ISR did not significantly change in either amplitude or duration following irradiation. The enhanced synaptic activities following exposure to acute radiation is explained as a possible increase in amplitude of afferent ISR and also with increased sodium permeability at the subsynaptic membrane. The relatively higher radiosensitivity of the EPSP than that of the IPSP is discussed in relation to driving force and ionic permeability change. (P.C.H.)

26089 EFFECTS OF WHOLE-BODY X RADIATION ON SPINAL-CORD CONVULSIONS IN RATS. Antonia Vernadakis, Stanley Geel, and Paola S. Timiras (Univ. of California, Berkeley). p.290-7 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

The effects of irradiation on spinal-cord convulsions were studied in developing and aging rats. Newborn rats were irradiated with 50, 150, 250, and 500 R, respectively at 2 days of age. Spinal-cord convulsions were determined at 12, 21, and 40 days of age. Aging rats, $1\frac{1}{2}$ years of age, were irradiated with 500 R and spinal-cord convulsions were determined $2\frac{1}{2}$ months after exposure to irradiation. With the exception of 50 R, all rats irradiated at 2 days of age exhibited a significantly shorter hindlimb flexion than controls. Tonic hindlimb extension was longer in the irradiated rats at 12 days of age and shorter at 21 and 40 days of age than in the appropriate controls. Differences were not observed in the intensity of spinal-cord convulsions in rats irradiated at $1\frac{1}{2}$ years of age as compared to controls. It was concluded that irradiation significantly increased the activity of spinal reflex systems in developing rats. The degree of the response was dose dependent. The decline in the radiosensitivity of the central nervous system with age is discussed. (auth)

26090 HISTOCHEMICAL AND HISTOLOGICAL CHANGES INDUCED IN RAT BRAIN BY X IRRADIATION. R. H. Brownson, D. B. Suter, J. L. Oliver, E. H. Ingersoll, and D. H. Burt (Medical Coll. of Virginia, Richmond). p.307-35 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Rats of various ages were exposed to limited head x irradiation in doses ranging from 500 to 10,000 R. The animals were sacrificed at postradiation intervals from 1 hour to 53 days. The central nervous system was explored by histochemical and histological methods. Histochemical procedures for acid phosphatase indicated that this enzyme, or the cell organelle containing it, responded to x irradiation of 5000 R or higher. This response was manifested by enlargement or clumping of acid phosphatase-positive granules within the cells. These changes became apparent at about 48 hours following irradiation and were most marked in Purkinje cells and portions of the brain characterized by high cell density. The changes resulting from irradiation in the amount or localization of formazan deposition were primarily an increase in reactivity of blood vessels, astrocytes, and reactive microglia. Also with doses of 4000 R and up, there appeared to be an increase in size of the enzyme-positive granules within neurons, or their aggregation into larger particles. Time after exposure (early acute) or (delayed chronic) seemed paramount to the degree of tetrazolium reduction in altered cells. Radioprotective drugs were not observed to alter morphology or the formazan deposition in radiated tissues. The increased rate of formation of myelin figures from the cut surface of the radiated-chronic brain may be related to the intactness of the myelin structures therein. (auth)

26091 RESPIRATORY GAS EXCHANGE OF CEREBRAL CORTEX, HYPOTHALAMUS, AND AORTA OF ADULT RATS AFTER EARLY POSTNATAL WHOLE-BODY X RADIATION. Paola S. Timiras, Jaime A. Moguilevsky, and Stanley Geel (Univ. of California, Berkeley). p.365-76 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Oxygen consumption and carbon dioxide production of neural (cerebral cortex and hypothalamus) and non-neural (aorta) tissues were compared in approximately 3-month-old rats exposed to a single 500 R dose of whole-body x irradiation on the second day after birth. Aerobic and anaerobic metabolism was measured by the manometric method of Warburg at 37°C in Krebs-Ringer phosphate medium for $-Q_{O_2}$ (wet weight) and Krebs-Ringer bicarbonate medium (pH 7.4) for $Q^{N_2}_{CO_2}$ (wet weight). Radiation significantly increased oxygen consumption of cortex and aorta, but not of hypothalamus; carbon dioxide production was significantly decreased in cortex, decreased moderately in aorta, and remained unchanged in hypothalamus. Adrenal hypertrophy and pronounced testicular atrophy were

also present in irradiated rats. The hypothesis was formulated that some of the effects of radiation on aerobic and anaerobic metabolism might be mediated, at least in part, through endocrine alterations. Comparison of rats castrated or irradiated at an early age indicated, however, that radiation affected mainly the cortex, whereas castration affected mainly the hypothalamus. Corollary studies were conducted to investigate the effects of aging and of repeated electroshocks on oxygen uptake and carbon dioxide production of cortex, hypothalamus, and aorta. Changes induced by radiation on metabolism of brain tissues were correlated with concomitant changes in brain excitability induced by the same x-ray dose, and indicated that irradiation in newborn rats can induce long-lasting biochemical and electroconvulsive alterations in the brain. (auth)

26092 THE EFFECT OF IONIZING RADIATIONS ON LIPID SYNTHESIS IN BRAIN AND LIVER. Enrica Grossi, Maria Poggi, and Rodolfo Paoletti (Universita, Milan). p.388-402 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Studies were made on the effects of x irradiation on the increased biosynthesis of lipids in liver and decreased biosynthesis of lipids in brain of rats. It was determined that the effects of irradiation are not due to changes in glucose levels available to the tissues, and the increase in lipid synthesis after radiation seemed to be specific for the liver. The actual reason for the increased lipid synthesis in the liver was clarified. The results showed that the liver of irradiated animals has an increased synthesis that is sensitive to the physiological feedback mechanism. Thus, the increased liver lipid synthesis is a reaction to an impairment of the normal exchanges between liver and plasma cholesterol. Cysteamine protected the liver and brain of the irradiated rats against lipid biosynthesis from acetate remarkably well. However, the opposite effect was found with synkavite when administered to animals submitted to 2000 R x irradiation. (P.C.H.)

26093 A PHARMACOLOGICAL ASSESSMENT OF THE CHANGES IN THE CENTRAL NERVOUS SYSTEM FOLLOWING X IRRADIATION. V. Nair and L. J. Roth (Univ. of Chicago). p.421-47 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

The effects of x irradiation on the central nervous system of rats were studied by means of pharmacological and electrophysiological methods. Three kinds of indicators having different physiochemical properties were employed to assess the nature of the damage to the blood-brain barrier. When ^{131}I-labeled serum albumin was used as the indicator, no permeability change was detected in the irradiated brain. With ^{35}S-labeled sodium sulfate as indicator, increased penetration into specific brain regions was noted 48 hours after irradiation, the hypothalamus showing the greatest increase. In general, permeability of the blood-brain barrier was less affected by 10,000 R x irradiation than by other treatments such as Metrazol seizure or imbalance. Employing the slow-penetrating anticonvulsant drug acetazolamide as an indicator, potentiation of its pharmacological and electrophysiological effects was seen following irradiation. These effects were temporally related to increased penetration of drug (studied with ^{35}S-labeled acetazolamide) into specific brain regions (cerebral cortex, hypothalamus, hippocampus, and cerebellar cortex). It is suggested that the rodent brain is relatively radioresistant to changes in the blood-brain barrier. Damage of the blood-brain barrier following 10,000 R x irradiation to head of rats was of a subtle nature and was demonstrable only with selected indicators. Therefore, it seems that radiosensitivity of the brain varies from one region to another. (P.C.H.)

26094 RADIATION-INDUCED CHANGES IN MORPHOLOGICAL AND PHYSIOLOGICAL PROPERTIES OF IMMATURE CEREBELLAR CORTEX. Robert J. Shofer, George D. Pappas, and Dominick P. Purpura (Columbia Univ., New York). p.476-507 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Postnatal effects of total head x irradiation (2000 R) on feline cerebellar cortex were studied with respect to changes in developmental patterns of local and afferent evoked responses and alterations in the morphogenesis of Purkinje cells and related synaptic pathways. Afferent evoked responses in the paramedian lobule (PML) in normal kittens exhibited relatively simple wave forms and lack short and long-latency components until after the second or third postnatal week. Locally evoked responses to folial surface stimulation did not acquire graded surface-negative characteristics typical of adult animals until the end of the third week. Functional consequences of destruction of the external granular layer and radioinduced changes in the development of Purkinje cell dendrites and superficial axodendritic synaptic pathways were seen in increased excitability and complexity of afferent evoked responses and the failure of locally evoked activities to develop components seen in normal kittens of comparable ages. These short term (1 to 3 postnatal weeks) effects of cerebellar irradiation are considered reflections of: maturation acceleration of pathways contributing to short and long-latency PML responses; insufficient elements eventually involved in the elaboration of superficial axodendritic synaptic pathways; and changes in the properties of Purkinje cell dendrites and dendritic synaptic systems. (auth)

26095 CABLE PROPERTIES OF NERVE IN AN INTERPRETATION OF RADIATION-INDUCED FUNCTIONAL CHANGES IN THE CENTRAL NERVOUS SYSTEM. Fred Rosenthal (Univ. of Washington, Seattle). p.509-21 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Exposure to doses of x rays below 1000 R was followed by a variety of changes in the function of the central nervous system of mammals. These changes, discussed in terms of three categories, were: the magnitude of spontaneous and evoked activity was increased at the lower doses or in the immediate postirradiation period (or both) and was decreased at higher doses or later in the postirradiation period (or both); excitability of neural systems was generally enhanced with x-ray doses below 1000 R; and the time course aspects of neural response were most often increased after irradiation. It is suggested that these three types of radioinduced functional change reflect x-ray effects on the cable properties of nerve, i.e., the resting potential, and the resistance of external fluid, axoplasm, and membrane. (P.C.H.)

26096 EFFECT OF LAMINAR LESIONS ON EVOKED ACTIVITY IN THE VISUAL CORTEX. Leonard I. Malis (Mount Sinai Hospital, New York). p.522-40 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Data on 89 cats, which were collected from 1957 to the present, are reported. Under sterile conditions, pentobarbital-anesthetized cats were subjected to craniotomy to expose the visual area on the right side. The dura was not opened. Laminar lesions were produced with peak doses of 20,000 to 40,000 Rad protons. After a range of postirradiation times from 2 days to 2 years, the animals were studied in acute terminal experiments. Visual evoked potential maps of the cortex over laminar lesions showed little change in the responses, with some enhancement around the edges of lesions. Microelectrode punctures did not show a significant change in the ability of visual stimuli to elicit a discharge from the cells above laminar lesions. Superficial ablation lesions showed that evoked cortical responses from photic stimuli lose initial surface positivity when the zonal lamina is destroyed, and that surface negativity is enhanced. With optic nerve stimuli, the ablation of the zonal lamina shortened the latency of the first two positive waves, but did not otherwise alter these two waves. However, there was marked alteration, and perhaps inversion, of the third and fourth surface-positive waves. (P.C.H.)

26097 ACTION OF GAMMA RADIATIONS ON RETINAL, GENICULATE, AND CORTICAL RESPONSES TO PHOTIC STIMULATION. Marcel Monnier and L. Hoesli (Universi-

tat Vesalianum, Basel). p.541-53 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

The action of weak (400 R) and strong (1200 R) gamma irradiation on the visual system was investigated in the unanesthetized rabbit. The electrical responses of the retina, lateral geniculate body, and optic cortex (including adjacent limbic cortex) to photic stimulation were recorded during 5 hours after irradiation. The action of gamma radiations on all components of the cortical response (latency, amplitude, and culmination time of the first positive component, of the following intercurrent negative potential, and of the late negative potential) were analyzed. The latency of the retinal and geniculate response and of the various components of the cortical response decreased progressively, with a maximum 4 hours after irradiation. The decrease in latency was stronger after 1200 R than after 400 R irradiation; it started within 1 hour after strong irradiation (1200 R), but somewhat later in the weak-irradiated animals. The amplitude of the ERG increased slightly 2 hours after weak irradiation (400 R); this effect lasted over 5 hours. Stronger irradiation (1200 R), however, decreased the amplitude, suggesting some damage. The amplitude of the cortical response did not increase always in proportion to the decreased latencies. However, decrease in latency and increase in amplitude, when they occur synchronously, suggest an increased excitability and conduction velocity of the visual system; this can be attributed to an initial activating influence of the gamma rays on the whole optic system. (auth)

26098 ELECTROPHYSIOLOGICAL CHANGES OF THE CENTRAL NERVOUS SYSTEM IN RESPONSE TO LOW-LEVEL RADIATION. Crawford F. Sams, Robert B. Aird, Gail D. Adams, and George L. Ellman (Univ. of California, San Francisco). p.554-73 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Dogs with coaxial electrodes implanted bilaterally in the cortex, in both dorsal hippocampi and in the anterior ventral nucleus of the hypothalamus were given single acute exposures of x irradiation with low doses involving the head only. Four series of 5 dogs each, plus 1 additional dog, were used. One control series of dogs was processed under identical conditions with the other four series, but received no irradiation. The other three series received 1, 10, and 100 Rad respectively of midbrain-absorbed dose of x irradiation. One dog received a dose of 2 Rad. Paper EEG recordings were made before, during, and following x irradiation. Illustrative examples of the responses are presented, since the lower-dose effects were of primary interest. The electrophysiological changes found were not seen in the control series at any time. They were not seen in dogs before irradiation, nor were they observed following recovery from the irradiation response. The magnitude, intensity, and duration of the EEG effects observed appeared to be dependent upon the doses of x irradiation delivered. The results suggest a functional response of the brain to low-level doses of x irradiation. The type of changes noted following irradiation included sporadic spiking and clusters of high-frequency spikes, which were suggestive of the preconvulsive state. The spiking usually began in the cortex, but ultimately included all levels of the brain recorded. A marked increase in EEG voltages appeared to be a particularly sensitive component of the functional response observed. The development of bilateral asynchrony secondary to the transient occurrence of unilateral cortical and hippocampal abnormality of the type mentioned, was noted. The data presented constitute a preliminary progress report on a long-term investigation concerned with the functional response of the central nervous system to low-dose x irradiation. (auth)

26099 HIPPOCAMPAL SPIKE ACTIVITY FOLLOWING LOW DOSES OF RADIATION. H. Gangloff (Universitat, Munich). p.574-90 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

The effects of isolated head or body irradiation with x-ray doses ranging from 10 to 1000 R on spontaneous cortical and subcortical activity are described in adult unanesthetized rabbits with intact brains and with septal lesions. Earlier findings were confirmed in more than 110 animals showing that head x irradiation causes hippocampal spikes to appear in primarily spike-free individuals, and that both head and body exposure reduced the hippocampal firing rate in those animals that showed pre-irradiation spike activity. Effects were seen at doses as low as 100 R in the spike-free group, and at 25 R in the group with spontaneous firing. The persistence, even at dose levels up to 1000 R, of spontaneous hippocampal theta rhythms, known to be triggered by medial septal-cell activity, does not fully rule out the possibility of a direct effect of radiation on other septal or septo-hippocampal mechanisms, as the possibility must be considered that two different mechanisms might be involved in the control of theta and hippocampal spike activity. The assumption that direct alterations of septo-hippocampal functions may occur, at least at higher doses, was also supported by the observation that immediate reduction of the hippocampal firing rate, seen with doses as low as 10 and 25 R, is lacking after head exposure to doses around 700 and 1000 R, whereas isolated body exposure to these higher doses still reduces firing immediately. Other central effects, possibly mediated indirectly by radiogenic action on deeper brainstem structures, were suggested at even lower dose levels (100 to 400 R) by the fact that hippocampal spiking required head exposure to appear in primarily spike-free animals and was not seen following isolated body irradiation. Immediate EEG responses, such as EEG arousal occurring in rabbits within seconds after dose rates as low as 0.2 to 0.3 R per second, were most certainly, at least in part, due to effects of radiation on peripheral receptors so far undetermined, but activating the brain stem reticular arousal system through afferent pathways. No signs of circulatory collapse were observed. (P.C.H.)

26100 ELECTROENCEPHALOGRAPHIC AND BEHAVIORAL EFFECTS FROM X IRRADIATION OF THE HIPPOCAMPAL SYSTEM. R. L. Schoenbrun (Univ. of California Center for Health Sciences, Los Angeles), E. Campeau, and W. R. Adey. p.591-620 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

The effects of ionizing radiation on specific brain-wave correlates of resting behavior and conditioned approach performance were examined in 13 cats. Radiation was administered either to the whole brain or focally to the hippocampus by means of a narrow collimated beam. Focal hippocampal irradiation enhanced synchronous slow-wave activity and spike discharges in the hippocampus. Motor activity during resting behavior was depressed, and decrements in conditioned approach performance occurred. Whole-head irradiation produced excessive oral behaviors and irregular synchrony at low dose levels and produced regular synchrony and spike discharges at high dose levels. Combined whole-head and focal control exposures produced anorexic illness and lethargy associated with performance decrements and brain-wave abnormalities. Evidence of the development of radiation tolerance to fractionated doses is presented. Evidence from a new impedance measuring technique supported the view that these radiation effects may involve neuronal and glial tissue compartments in aspects of changing membrane permeability. (auth)

26101 EFFECTS OF REPEATED SMALL DOSES OF GAMMA RADIATION ON CONDITIONAL REFLEXES. L. J. Peacock and W. T. James (Univ. of Georgia, Athens). p.625-31 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964. (TID-19044)

The effects of repeated small doses of gamma irradiation on classic conditioning phenomena in dogs were investigated. The results suggest that dogs undergoing Pavlovian conditioning procedures react in quantitatively and qualitatively different ways, depending upon as yet unknown factors in their constitution or prior experience. The data also support the contention that small doses of radiation

affect behavior as measured by the classic conditioning paradigm. The possibility remains that more complicated conditioning situations, involving discrimination of stimulus patterns and their temporal relations, will reveal effects not seen in simple conditioning. Doses of radiation on the order of 20 R had no observable effect on simple salivary conditional responses or on the conditional cardiac acceleration that may accompany such conditioning. (P.C.H.)

26102 EFFECTS OF PRENATAL X IRRADIATION ON THE BEHAVIORAL DEVELOPMENT OF THE ALBINO RAT. Jack Werboff, Joan Havlena, and Melvin R. Sikov (Wayne State Univ., Detroit). p.632-8 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Behavioral changes following prenatal radiation exposure with doses of less than 100 R administered at various days of gestation were investigated. Evaluation of behavioral performance early in the life history of the individual demonstrated interaction effects between dose-response and stage-dependent parameters. An inability to demonstrate alterations in the behavior of the newborn animal and apparently differential effect of the treatments on males and females was found. (P.C.H.)

26103 THE AUTONOMIC NERVOUS SYSTEM AND AVOIDANCE CONDITIONING TO IONIZING RADIATION. Jack Arbit (Northwestern Univ., Chicago). p.639-51 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Three experiments and a reanalysis of the data of a previously reported study are presented in order to show the effects of the autonomic nervous system upon spatial avoidance conditioning to ionizing radiation. Using the amount of defecation occurring in a novel, open-field apparatus, it was found that animals of different genetic strains that respond with different degrees of emotional elimination in the open-field test also differ in the degree to which they acquire the avoidance response. The results indicate that although ganglionic blocking drugs do not prevent the establishment of avoidance behavior, they tend to reduce the extent to which the avoidance is manifest in animals that begin the experiment with relatively high emotional elimination scores, whether this is a result of selection of animals within a specific genetic strain or of animals of two different strains having different tendencies toward emotional elimination. Lastly, an attempt was made to develop an emotionally reactive and an emotionally nonreactive group of rats by exposing some animals to unavoidable traumatic experiences. There was a tendency, not statistically significant, for the animals exposed to the stress experiences to become emotionally nonreactive and to acquire the avoidance response to a lesser extent than the animals not specifically traumatized. The findings are interpreted as indicating that x radiation either directly or through some sensing mechanism may stimulate autonomic-nervous-system structures and that the animal perceives this arousal as noxious or uncomfortable since it normally occurs and thus has been associated with stress and fear conditions. This serves to motivate the animal to learn to avoid those cues associated with the arousal of this disquieting state of affairs. Animals not prone to respond readily to stress do not acquire the avoidance behavior as well. (auth)

26104 CONDITIONED BEHAVIOR AND THE RADIATION STIMULUS. Donald J. Kimeldorf and Edward L. Hunt (Naval Radiological Defense Lab., San Francisco). p.652-61 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

The arousal phenomenon in sleeping animals was used to demonstrate an immediate perception of x-ray exposure at low dose rates. One-second x-ray bursts, at dose rates in the range of 0.05 to 3.2 R per second, were found capable of eliciting an arousal reaction in the inactive ophthalmectomized rat. Whole-body exposure is not essential. A 1-second exposure at 1.0 R per second will elicit arousal with either partial-body or head exposure; head exposure, however, is more effective. The relationship of prompt perception, as manifested by the arousal reaction, to radiation-conditioned behavior is not definitive. While radiation may induce neural activation and evoke perception of the exposure, the response appears to be transient. Continued exposure at an effective dose rate (0.25 R per second) does not lead to a greater incidence of arousal, suggesting that adaptation to the stimulus, fatigue, or suppression of the reaction readily occurs. The failure to sustain arousal with prolonged exposure suggests that the major motivational properties of radiation in the learning situation resides in more persistent changes in the functional state which have not been identified as yet. (auth)

26105 IONIZING RADIATION AS A PERCEPTUAL AND AVERSIVE STIMULUS. 1. INSTRUMENTAL CONDITIONING STUDIES. J. Garcia (Long Beach State Coll., Calif.). N. A. Buchwald, B. H. Feder, R. A. Koelling, and L. F. Tedrow. p.673-86 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Studies were made in which x rays were used as a perceptual (conditioned) stimulus or signal rather than as a drive (unconditioned) stimulus. The results demonstrated that radiation has immediate effects similar to other stimuli. Basically, three types of observations were made. Radiation was used as a novel stimulus to elicit activation. Sleepy animals were aroused. Animals engaged in behavior stopped and oriented when exposed to a brief period of irradiation for the first time. Radiation was employed as a warning stimulus to signal the occurrence of a subsequent shock to the animal's paw; the defensive responses to shock quickly became conditioned to the x-ray signal. This response is described as learned fear or conditioned emotional response. Animals were given discrimination training with x ray. They were trained to press a lever for food in the absence of x ray and to take time out during the exposure period in order to avoid an electric shock. The conditioning procedure is discussed in detail. Some data are also included on conditioned suppression of drinking. The results indicated that the animals cannot reliably detect doses as high as 0.50 R per second to the body when the head is shielded. (P.C.H.)

26106 IONIZING RADIATION AS A PERCEPTUAL AND AVERSIVE STIMULUS. II. ELECTROPHYSIOLOGICAL STUDIES. N. A. Buchwald (Univ. of California Center for Health Sciences, Los Angeles), J. Garcia, B. H. Feder, and G. Bach-y-Rita. p.687-99 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Electrophysiological changes that occur in the cortical electroencephalogram when small doses of x ray are used to produce arousal or orienting responses are reported, and these immediate responses were contrasted with the aversion properties of radiation. Previously determined conceptual and methodological issues are discussed. In one experiment, the rat was exposed to x irradiation for 10 sec. Responses were counted as positive if the record showed a change from slow or spindly to fast, low-voltage activity within 2 sec. Nearly all responses, however, occurred with a latency of less than 1 sec after the onset of x-ray exposure. At doses as low or lower than 0.2 per second, the EEG record showed that desynchronization occurred once, and usually the animals were observed to awaken. It was concluded that low doses of radiation can act as stimuli to produce important alterations in behavior and in neural activity a number of ways. A two-factor theory for x-ray detection based on demonstrations that parameters of latency, dose rate, and locus of x-ray sensitivity were very different for radioinduced aversion (x rays used as unconditional stimulus) and for detection of x ray (x rays used as conditional stimulus) is proposed. (P.C.H.)

26107 AFFERENT NEURAL ACTIVITY ELICITED BY LOW-LEVEL RADIATION. Charles D. Barnes (Univ. of California, San Francisco). p.700-7 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

The afferent activity of splanchnic and vagal nerves in

rats and in cats was recorded continuously before, during, and after the exposure to x irradiation administered at a rate of 32 R per minute for no more than a total dose of 400 R. No difference was found in the response pattern to irradiation of the corresponding nerves in the two species. The splanchnic nerve exhibited an increase in afferent activity within 1 second from the onset of irradiation and returned to the preirradiation level soon after the cessation of irradiation. The amount of afferent activity in the vagus nerve did not appreciably change when the animal was subjected to irradiation at the rate and total dose studied. The results lend credence to the hypothesis that the physiological changes resulting in behavioral and electroencephalographic changes take place at the periphery and are mediated, in part at least, by afferent fibers in the splanchnic branch of the sympathetic trunk. (auth)

26108 BEHAVIORAL EFFECTS OF RADIOLESIONS IN THE BRAIN OF THE PIGEON. Eric Fabricius (Univ. of Stockholm). p.708-21 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Brain lesions produced by local irradiation with high-energy protons were used to study the role of the cerebral hemispheres in the control of behavior in pigeons. Complete intersection of the cerebral peduncles resulted in a total loss of spontaneous feeding and drinking, escape responses, and social behavior. Balancing movements and an advanced visual control of locomotion persisted, including the ability to avoid obstacles during flight and to make precision landings. Transsection of the cerebral peduncles except part of the tractus occipitomesencephalicus gave similar symptoms, except that escape responses persisted for a longer period. In birds with more rostral lesions, sparing the posterior portion of the lateral forebrain bundle as well as the tractus occipitomesencephalicus, the ability of spontaneous eating and drinking persisted, as well as the escape responses, and even social behavior was observed. Transsection of the median forebrain bundle (tractus septomesencephalicus) produced no obvious behavioral changes, except for some very slight abnormalities in copulatory behavior in one bird and a slight impairment of retention in learning tests in another. Restricted lesions in various parts of a basal ganglia had, as a rule, no visible effect on behavior. Since the most severe disturbances of behavior were caused by transsection of the lateral forebrain bundle, which constitutes the main nervous connection to the basal ganglia, it was concluded that important parts of neural mechanisms involved in the control of behavior in birds are located in the basal ganglia. Observations are described that seem to indicate that the archistriatum may cooperate in the control of escape behavior. (P.C.H.)

Radiation Effects Therapy and Countermeasures

Refer also to abstract 26011.

26109 (ORINS-49(p.40-62)) STUDIES RELATED TO TREATMENT OF RADIATION INJURY. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.).

Progress is reported in studies related to the treatment of radiation injuries in man and laboratory animals. Results are reported from studies on the feasibility of bone marrow grafts in irradiated patients, the effects of marrow grafts on lethal radiation injuries in animals, and immune reactions to marrow grafts. Data are included from studies on nitrogen balance in mouse radiation chimeras, the effects of isologous and homologous marrow transplants on the lipid composition of tissues in mice, immune reactions of irradiated mice to rat bone marrow transplants, the effects of the mercaptan compound, penicillamine, on primary immune responses in mice, antigens and blood picture of the South American marmoset, Tamarinus nigricillis, the effectiveness of homologous marrow transfusions in protecting Tamarinus against lethal and supra-lethal whole-body irradiation, and immune reactions in inbred mice. (C.H.)

26110 THE EFFECT OF ERYTHROPOIETIN IN EXPERIMENTAL PHENYLHYDRAZINE AND IRRADIATION-PROVOKED ANEMIA. I. Baciu, E. Rosenfeld, M. Dorofteiu, M. Telia, M. Rusu, and E. Cuparescu (Institutul de Cercetari Medicale, Cluj). Acad. Rep. Populare Romine, Filiala Cluj, Studii Cercetari Med., 12: 19-32(1961). (In Rumanian)

Some experimental studies made on 88 rats and 80 mice to establish the therapeutic and protective effects of erythropoietin on hemolytic and irradiation-induced anemia are reported. In hemolytic anemia, produced by the administration of phenylhydrazine to rats, erythropoietin administered the day after treatment by phenylhydrazine for three days causes an extreme reticulocytosis and a very rapid re-establishment of the normal rate of red blood corpuscles. In the animals irradiated by sublethal doses of x rays (590 R), erythropoietin, administered six days after irradiation in three daily doses did not affect the percent lethality. The administration of erythropoietin to animals irradiated fractionally (200 R every 5 doses) caused for short duration a reticulosis three times as extreme as that of the samples and prevented the drop of red blood cells and hemoglobin. The lethality of the treated animals was not affected in relation to the mortality in the samples. The erythropoietin administered before a single dose of 650 R assured the survival of the irradiated animals for 30 days after irradiation at a rate of 70% with respect to the samples with a 100% lethality; in the case of a single dose of 500 R, erythropoietin administered before irradiation assured the survival of all the animals injected and irradiated whereas only 70% of the controls survived. (P.C.H.)

26111 THE USE OF REGENERATING BONE MARROW TO PROTECT GUINEA PIGS AGAINST LETHAL IRRADIATION. P. F. Harris and J. H. Kugler (Univ. of Sheffield, Eng.). Acta Haematol., 32: 146-67(Sept. 1964).

An attempt was made to identify the earliest forms of stem cell in bone marrow by use of bone marrow transfusion. Guinea pigs which were recovering from sublethal whole-body irradiation were used to supply bone marrow for transfusion into lethally irradiated animals. Animals were irradiated with a ^{60}Co unit, those used as bone marrow donors being given 150 to 200 Rad whole-body irradiation. Recipient animals were divided into two groups. The 1st group each received 600 Rad before transfusion, and the 2nd 720 Rad. For determination of lethal dose of irradiation in this strain (Dunklin-Hartley) of guinea pigs, groups of six were irradiated at intervals of 50 Rad over the range 550 to 800 Rad whole-body irradiation. A dose of 600 Rad was found to be lethal to 33% of animals within 15 days of irradiation, and 720 Rad was lethal to 100% within 15 days. Thirteen days after sublethal irradiation of the donor animal its bone marrow was removed and transfused into a litter-mate, which 24 hr previously had received 600 or 720 Rad. In guinea pigs receiving 600 Rad the mean number of bone marrow cells transfused into each animal was 88.5×10^6, and in those given 720 Rad it was $115.2 \pm 17.7 \times 10^6$. The transfused marrow was in the early stages of final hemopoietic recovery following irradiation, and had an unusual cellular composition. Differential cell counts of samples of the transfused marrow are given. In the transfused marrow 70 to 80% of the cells were mononuclear forms, most being small- or medium-sized lymphocytes. The remainder were lymphocyte-like cells which had blast features and were able to proliferate; some were very small, resembling micromyeloblasts or hematogones. The transfused marrow was excessively fatty and contained very few granulocytic and erythroid cells, their early forms being particularly scarce. After transfusion, blood neutrophil and red cell levels recovered promptly but restoration of blood lymphocytes was very slow despite the composition of the transfused marrow. There is evidence that a small fraction of leucocytes in the blood of normal and irradiated animals can synthesize DNA, and among leucocytes there is a stem-cell group which can protect against lethal irradiation. These cells also promote red cell regeneration,

and thus support the monophyletic theory of hemopoiesis. The unusual forms of leucocyte circulating in the blood of the transfused animals shortly after marrow transfusion were interpreted as being as stem-cells since some of them had blast characteristics. However, they were not found in the original transfusion. Some, notable for their large size, might have arisen as the result of initial irradiation of the donor marrow. (BBB)

26112 STUDIES ON THE PRIMARY SYMPTOMS OF POST-IRRADIATION DISEASE. Romuald Kulesza and Stanislaw Lipinski. Acta Physiol. Polon., 16: 9-17(1965). (In Polish)

Studies on the main primary symptoms of postradiation disease, namely the vomiting reflex, are reported. Experiments were carried out on dogs of both sexes weighing 7-22 kg, which were submitted to whole-body x irradiation (dose 12 R/min, total dose on the body 600 R, 20 mA, 180 kV, 0.5 mm Cu filter). The dogs were fasted before irradiation. Duration and frequency of vomiting reflexes were studied. With the purpose of elucidating the mechanism of the vomiting reflex after irradiation, pharmacologic agents with various points of action, i.e. in the central nervous system or in the vegetative nerve endings, were administered. The drugs included phenactil (largactyl), aviomarine, atarax, atropine, spasmophen, and regitine. Drugs acting on the central nervous system, such as phenactil, aviomarine, and atarax, diminished the number of vomiting reflexes in the experimental dogs. Drugs paralyzing the parasympathetic nervous system diminished or even abolished the vomiting reflex in the irradiated animals. Administration of drugs paralyzing the sympathetic system had no distinct inhibitory effect on the vomiting reflex. In order to determine the role of the vomiting centers in the studied phenomenon, additional experiments were performed in which the same pharmacologic drugs were administered, followed after 10 minutes by apomorphine. From a comparison of the results of the experiments with irradiated dogs and those in which apomorphine was administered it was concluded that the vomiting reflex in irradiated animals is the result of stimulation of the parasympathetic nerve endings. Inhibition of vomiting reflexes by drugs acting on the central nervous system in irradiated dogs may be explained as a result of inhibition or blocking of the vomiting center previously stimulated by peripheral impulses. (auth)

26113 CONTRIBUTION A L'ETUDE PHARMACOLOGIQUE DE LA PADUTINE (KALLIKREINE PANCREATIQUE). (Contribution to the Pharmacological Study of Padutine (Pancreatic Kallikrein)). H. Laborit (Hopital Boucicaut, Paris), F. Letterier, A. Massart, and C. Baron. Agressologie, 6: 623-5(1964). (In French) (EUR-1266.f)

A pharmacological study of Padutine (pancreatic kallikrein) is reported. Similarities between the action of bradykinine and amino-ethyl-isothiouronium (AET) are pointed out. It was concluded that Padutine, and consequently bradykinine (or Kallidine) reduce NADP. The mechanism through which Padutine and AET assure the favorable action in the healing processes is discussed. (P.C.H.)

26114 THE USE OF BONE MARROW TRANSPLANTS IN THE PROTECTION OF RHESUS MONKEYS AGAINST TOTAL BODY X-IRRADIATION. J. R. Allen, J. L. Van Lancker, and R. C. Wolf (Univ. of Wisconsin, Madison). Am. J. Vet. Res., 25: 1740-5(Nov. 1964).

Doses of 700 R were invariably lethal when total-body x irradiation was administered to rhesus (Macaca mulatta) monkeys. They were irradiated with a 250-kv x-ray generator at a dose rate of 12 R/min. Some monkeys were given female bone marrow transplants intravenously (4.5×10^8 to 21×10^8 cells per monkey). Five of the 10 marrow-treated monkeys are still alive, having survived from 120 to 330 days; the other five treated animals had a mean survival time of 21.5 days. Definite indications of active hematopoiesis were evident in the bone marrow of three treated monkeys that died. Death in a large percentage of the control monkeys resulted from widespread hemorrhage, anemia, and terminal bacteremia. In the treated monkeys that died, severe hemorrhage and anemia were observed in four and bacteremia in one. Myocardial hemorrhage was seen in two of 10 control monkeys. Fatty infiltration, degeneration and foci of necrosis were noticed in five of 10 irradiated control monkeys. Extensive hemorrhage and edema were constant features in nearly all irradiated monkeys that expired, regardless of treatment. Gastrointestinal hemorrhage in the mucosal and muscular layers were observed in all control monkeys. Extensive muscular hemorrhage was seen in many areas of the body, and ranged from petechial to ecchymotic. In the testes of the irradiated monkeys, the germinal epithelium of the seminiferous tubules was in various stages of degeneration. In some tubules, only the Sertoli cells remained. The effect of x irradiation on the hematopoietic tissue of monkeys was marked. Within a 2-week period, the number of red blood cells was reduced by one-half and the white blood cells were less than 500 per mm^3. The platelets were one-tenth their original value; the hematocrit values were decreased by one-fifth; and the hemoglobin was one-half its original level. These data indicate a nearly complete cessation of blood formation. The monkeys given bone marrow transplants had similar but less severe alterations in the peripheral blood values. The blood values of the surviving treated monkeys returned to their original levels within 8 weeks. One of the first indications of the reestablishment of active hematopoiesis was associated with the rise in the reticulocyte count. There was a slight decline in the total serum proteins of all irradiated monkeys, with a shift in the albumin/globulin ratio during the initial 3 weeks postirradiation. The livers from monkeys that expired during this period explained this decrease in albumin. There was extensive fatty infiltration, areas of central lobular necrosis, and marked distortion and disruption of the parenchymal cells. The repopulation of the bone marrow in monkeys subjected to total-body irradiation could arise from the donor cells or from surviving bone marrow cells of the irradiated monkey. The first explanation seems correct, since the presence of a higher percentage of drumsticks on the neutrophils of the males given transplants indicated that the regenerating marrow arose from the donor source rather than from regeneration of the existing marrow. (BBB)

26115 ON THE CHEMICAL AND BIOLOGICAL PROTECTION AGAINST IONIZING RADIATION DAMAGE. VI. EFFECTS OF ADMINISTRATION OF BASIC TISSUE POLYPEPTIDES ON ACUTE AND CHRONIC INTOXICATION FROM X RAYS. P. De Rinaldis and R. Pantaleo (Universita, Bari, Italy). Ann. Med. Navale (Rome), 69: 5-16(Jan.-Feb. 1964). (In Italian)

Forty adult rabbits were divided into four treatment groups: a single dose whole-body irradiation group, whole-body irradiation and calf-thymus polypeptide injection group, fractionated whole-body irradiation group, and finally, a fractionated irradiation and polypeptide injection group. All animals received a total dose of 2000 R of 180-kv x-ray, and some, additionally, a peptide preparation from calf thymus. A survival period of 4.2 hr was observed in the acute whole-body irradiation group. In the animals treated intravenously with 5 mg polypeptide for each kg body wt one hr before acute (single dose) whole-body irradiation, the survival period was 26.2 hr. In the group that received whole-body irradiation only, but fractionated in a daily dose of 100 R, the survival time was 20 days. The animals receiving daily injections of 5 mg of polypeptide and daily 100-R whole-body irradiation showed a survival period of 32 days. The results demonstrate a mild biological protective action of the polypeptide; moreover, it is completely harmless in contrast to some chemical radiation protectants. (BBB)

26116 CHEMICAL INFLUENCE ON IRRADIATION SENSITIVITY OF VARIOUS EXPERIMENTAL NEOPLASMS. R. Koch and I. Seiter (Universitat, Freiburg i. B.). Arzneimittel-Forsch., 14: 1018-21(1964). (In German)

The effects of several radioprotective agents and antimetabolic substances on the radiosensitivity of various experimental tumors in mice were investigated. When irradiating Ehrlich ascites tumor in vitro, 6-aminonicotinic

acid amide and tetra-sodium-2-methyl-1,4-naphthohydroquinone-diphosphate (Synka-ViT) surprisingly exhibited an unequivocal protective effect, while mono-iodoacetic acid was inactive. Cysteamine had no protective effect in vivo on a solidly growing sarcoma of reticulum cells. On the Crocker sarcoma, neither serotonin nor thiourea had any protective activity, although cysteamine, nicotinic acid amide, and Synka-Vit did. (auth)

26117 INVESTIGATION ON THE BIOCHEMICAL MECHANISMS OF OROTIC ACID IN RADIATION PROTECTION. M. Marchetti, B. Barbiroli, and C. M. Calderera (Universita, Bologna). Boll. Soc. Ital. Biol. Sper., 39: 1819-22(Dec. 31, 1963). (In Italian)

This study deals with the effect produced by orotic acid (given orally) on the RNA, DNA, nucleotides freed by the liver, and polynucleotide phosphorylase and aspartate carbamyl transferase activities in animals given a total-body dose of 600 R of ^{60}Co γ irradiation at a rate of 25 R/min. Adult rats were irradiated ventrally and dorsally with 300 R to each side. All animals were sacrificed after 48 hr and their liver tissue examined. The following values were observed in the controls, after irradiation only, and after irradiation with orotic acid treatment of 100 mg/100 g body weight: RNA as mg/g liver 13.1, 16.8, 15.8; DNA 2.1, 2.9, 2.7. The following acid-soluble liver nucleotide levels were observed in relation to the controls, the results being given as percent increase (+) or decrease (–) in irradiation only and irradiation with orotic acid animals: adenosine monophosphate (AMP) – 3, – 18 guanosine monophosphate (GMP) + 107, + 82; adenosine diphosphate (ADP) + 59, + 67; adenosine triphosphate (ATP) + 184, + 147; guanosine triphosphate (GTP) + 300, + 83. The following polynucleotide phosphorylase activity (as μmole of ADP utilized per hr and g of tissue) and aspartate carbamyl transferase activity (as μmole of carbamylaspartic acid produced per hr and g of tissue) values were observed in the controls, irradiation only, and irradiation with orotic acid animals: 11.7, 398; 8.7, 508; 12.3, 284. The normalization tendency produced by orotic acid in enzymatic activities which controls two basic nucleotide metabolic processes, such as polynucleotide synthesis and pyrimidine base synthesis, could at least partly explain the mechanism with which the orotic acid produces a protective effect, as seen by the prolonged survival of the irradiated animals. (BBB)

26118 REGENERATION ABILITY RESTORED WITH THE AID OF NUCLEIC ACID IN AXOLOTL EXTREMITIES, INHIBITED BY X-RAY IRRADIATION. L. V. Polezhaev, N. A. Teplits, and S. Ya. Tuchkova. Dokl. Akad. Nauk SSSR, 159: 682-5(Nov. 21, 1964). (In Russian)

A total of 75 black axolotl were given a local x-ray dose of 8000 R on the hind extremities while the rest of the body was shielded with lead 4 mm thick. Fifty of the animals were given a whole-body dose of 1000 R. A number of the locally irradiated animals were given an injection of 125 μg of RNA once a day for 5 days, or 85 μg of DNA in five daily shots, immediately after irradiation and 20 days after the irradiation. The recuperative ability of the extremities was noted with and without the trauma of an amputation. It was found that the application of RNA and DNA was effective in restoring the recuperative ability of the extremity, if they were administered immediately after the irradiation. X-ray ulcers disappeared when the limb regained its recuperative ability. The life span of the animals given a whole-body dose of 1000 R and treated immediately with RNA was increased almost by a factor of two from 33.2 days for the controls to 60.6 days for the RNA-treated animals. (TTT)

26119 ANTIMUTAGENIC AND MUTAGENIC EFFECT OF AMINO ACIDS ENDOWED WITH ANTI-RADIATION CAPACITY. N. P. Dubinin, V. K. Shcherbakov, and V. V. Surkov (Inst. of Biological Physics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 159: 913-14(Dec. 1, 1964). (In Russian)

The same compound at different concentrations can act as a radioprotective agent, an antimutagenic agent, or a chemical mutagenic agent. Thus, the number of anaphase rearrangements observed in onion shoots is ~6% when the shoots are grown in an arginine concentration 2×10^{-3} to 2×10^{-5} mg/ml. The controls showed 10.9% anaphase rearrangements. At a high arginine concentration of 2×10^{-1} mg/ml, the anaphase changes were found to be 14.1%. In experiments with Erlich ascites cells, arginine showed a mutagenic effect at concentrations of 2 and 20 mg/ml (11.4 and 14.1 anaphase changes respectively compared to 4.4% in the controls). Cystine, which has radioprotective properties, shows a clear mutagenic effect on onion shoots grown at a cystine concentration of 1×10^{-1}% (18.5% anaphase changes compared to 9.1% changes in the controls). These amino acids are mutagenic at high concentrations. It was established previously that streptomycin behaves similarly. (TTT)

26120 EXPERIMENTAL STUDIES ON THE PROBLEM OF CHEMICAL RADIATION PROTECTION OF THE LUNGS. I. THE EFFECT OF RUTIN ON RADIATION PNEUMONITIS. H. Hartweg and D. Lemanczyk (Medizinisches Strahleninstitut der Universitaet, Tuebingen, Ger.). Fortschr. Gebiete Roentgenstrahlen Nukleamed., 99: 818-23(Dec. 1963). (In German)

Twenty-one female rats were irradiated with 2000 R from a telecobalt source at a rate of 200 R/min directed to the thorax. Ten of the irradiated animals were treated with 50 mg of rutin, administered orally. After intervals up to 45 days the animals were killed, and their lungs studied histologically. The animals treated with rutin developed fewer manifestations of radiation pneumonitis. In a few of these animals there was diffuse interstitial inflammation, and usually this was peribronchial and perivascular. In 5 of the treated animals there were small inflamed foci scattered throughout the interstitium, with thickened alveolar septa. Three animals showed infiltration of round cells in the region of blood vessels and bronchi, but these also appeared frequently in the control animals. In 4 of the control animals that had died shortly after irradiation the lungs were grossly hyperemic, with alveolar hemorrhages. The alveolar septa were edematous and slightly thickened. The lungs of animals killed 45 days after irradiation were inflamed, particularly around the blood vessels and bronchi. The alveolar lumena contained an exudate with round cells and alveolar epithelial cells, but the bronchiolar lumena were generally not affected in this way. Some developing emphysema was observed in the lungs. Sclerosis, fibrosis, and hyaline membrane formation was not observed in the vessel walls. (BBB)

26121 THE EFFECTS OF POST-TREATMENTS WITH CYSTEINE AND SODIUM HYDROSULFITE ON THE RADIATION-INDUCED INJURY AND MUTATION IN RICE. Hikoyuki Yamaguchi (Tokyo Univ.). Ikushugaku Zasshi, 12: 8-12(1962). (In Japanese)

Studies were made on the effects of some chemical substances after γ irradiation on induced injury, sterility, and mutation in rice. The γ rays were generated by ^{60}Co and were applied at 1,000 R per hour. Germination was initiated by placing the seeds in solutions of 1×10^{-3} M cysteine and sodium hydrosulfite ($Na_2S_2O_4$) for a period of 48 hours at 30°C. The influences of cysteine and $Na_2S_2O_4$ on radiation effects, which were measured by survival at maturity of X_1 plants, degree of sterility in X_1 ears, and frequencies of chlorophyll mutations among X_2 populations, were compared with the results of γ irradiation alone. Data on all effects were gathered from the sample of seed in four replications of each treatment. Data on the effects of post-treatments with cysteine and $Na_2S_2O_4$ applied to irradiated rice seeds on the induced injury, sterility, and mutation are tabulated. The results demonstrate that both treatments applied during hydration of irradiated seeds modify certain of the radiation effects in rice. Radioinduced injury as measured by survival at maturity and radioinduced sterility were reduced by $Na_2S_2O_4$. Radioinduced mutation spectra as measured by chlorophyll mutations were affected by cysteine but not by $Na_2S_2O_4$. (P.C.H.)

26122 COMPARATIVE RADIOSENSITIVITY OF TWO STRAINS OF BACILLUS SUBTILIS ONE BEING WITHOUT ACONITASE. J. Stuyvaert, C. Liebecq, and Z. M. Bacq

(Universite, Liege). Intern. J. Radiation Biol., 8: 513-17 (1964). (In French)

Two strains of Bacillus subtilis, one being a mutant without aconitase, were studied. The mutant accumulates citrate inside the cell but is no more radioresistant than the wild strain, as indicated by the ability for a cell to give a colony and to incorporate radioactive uracil in its nucleic acid. The amount of citrate accumulated does not seem sufficient to bind magnesium inside the cell, or this ion does not play an important part in radiosensitivity. (auth)

26123 STUDY OF VARIOUS SUBSTANCES AS POSSIBLE MODIFIERS OF RADIOSENSITIVITY OF ESCHERICHIA COLI AND BACILLUS SUBTILIS; SENSITIZATION BY β,β'-DICHLOROETHYL SULFONE. J. Stuyvaert and Z. M. Bacq (Universite, Liege). Intern. J. Radiation Biol., 8: 519-22(1964). (In French)

$\beta\beta'$ dichlorethyl sulfone sensitizes E. coli to x-irradiation; an excess of Mg^{++} in the broth protects this organism. (auth)

26124 POLYSACCHARIDES AND EPILATION BY X-RAYS IN BLACK MICE. P. van Caneghem (Universite, Liege). Intern. J. Radiation Biol., 8: 541-4(1964). (In French)

Chondroitin sulphate, heparitin sulphate and hyaluronidase show a moderate protective effect on the pilary system of eight days old C_{57} black mice, when injected locally before irradiation with 550 R. Hyaluronic acid and thiomucase have no protective effect at the concentrations used. (auth)

26125 THE SENSITIZATION BY IODODEOXYURIDINE OF CULTURED HUMAN CELLS TO THE LETHAL EFFECT OF X-RAYS AND HEAVY IONS. R. Tym and P. W. Todd (Univ. of California, Berkeley). Intern. J. Radiation Biol., 8: 589-604(1964).

A long-term line of cultured cells of human-kidney origin grown for at least one doubling time in iododeoxyuridine (IUdR) is characterized by a reduction in growth-rate and plating efficiency. For these IUdR-treated cells, the in vitro sensitivity to the lethal effects of radiation is increased for x-rays and for 26.3 Mev ^4He ions, but not for 79.0 Mev ^{12}C ions. The extent of sensitization appears to be independent of oxygen-tension. The results are interpreted theoretically in terms of injury analogous to sublethal radiation damage, but induced by incorporation of IUdR: the ability of the cell to reverse the effects of sublethal radiation events is impaired. It remains to be seen whether the uptake of IUdR by human tumours in vivo could be sufficient to render them more sensitive to radiation therapy. (auth)

26126 A COMPARISON OF MUTATION AND KILLING OF ESCHERICHIA COLI WP2 BY GAMMA-IRRADIATION IN THE PRESENCE OF CHLORIDE IONS. Akira Matsuyama, Mitsuo Namiki, Yoshishige Okazawa, and Ichiro Kaneko (Inst. of Physical and Chemical Research, Tokyo). Intern. J. Radiation Biol., 8: 609-12(1964).

Two types of experiments were performed with Escherichia coli WP2 irradiated with ^{60}Co γ rays under aerobic conditions: irradiation by a constant dose with different concentrations of chloride ions and comparison of dose-effects on mutation induction in the presence and absence of chloride ions. A relationship suggesting the involvement of radioinduced non-chromosomal damage in the lethal events was found for irradiation in the presence of chloride ions. (H.S.D.)

26127 INACTIVATION OF UREASE IN VITRO BY MEANS OF TRITIATED WATER AND ITS RESTORATION WITH POLYCYSTEINE. F. Ascoli and G. Giovannozzi-Sermanni (CNR, Rome and Universita, Rome). Intern. J. Radiation Biol., 8: 613-16(1964).

The effects of radioprotective agents, sulfhydryl compounds in particular, were studied in irradiated urease. Glutathione, cysteine, or polycysteine were added to urease solutions in tritiated water. Urease was slowly inactivated by the tritium, reaching 34% inactivation after 6 hrs. Results further showed that inactivation was controlled by means of sulfhydryl compounds, especially the more concentrated ones. At certain concentrations of the chemicals, recovery was complete by one hr, beyond which time the activity in the same range of concentrations was not increased. Glutathione appeared to have more evident restorative power. It was concluded that the concentration of –SH groups is the most important factor in the restorative activity, regardless of the molecular weight of the compound tested. (H.S.D.)

26128 EFFECT OF AUTOLOGOUS MARROW BUFFY COAT ON SURVIVAL AFTER SUPRALETHAL IRRADIATION. Jack H. Bloch, Sadek Hilal, Jerrold K. Longerbeam, William G. Manax, William R. Scott, and Richard C. Lillehei (Univ. of Minnesota, Minneapolis). J. Am. Med. Assoc., 187: 729-33(Mar. 7, 1964).

A simple method is described for removing a liter of bone marrow from dogs weighing 15 to 30 kg and for separating the nucleated marrow cells in the buffy coat for use in combating irradiation sickness. The peripheral blood separated from the marrow cells is injected in the dog immediately, while the marrow cells in the removed buffy coat are stored for reinfusion after the irradiation. Marrow (300 ml from each humerus and 200 ml from each femur) was aspirated into iced (4.0°C) balanced salt solution (280 to 300 mOsm/1, pH 7.4) and stored at 4°C. The marrow was filtered through a No. 60 mesh stainless steel screen with a pore diameter of 150 μ, and centrifuged at 2000 rpm for 15 min to separate plasma, buffy coat, and red blood cells (RBC). Plasma was then aspirated from each bottle into a plastic transfusion bag, and the buffy coat from the surface of the RBC layer into a separate transfusion bag. From the liter of bone marrow from each dog, a buffy coat of 250 to 300 ml was obtained and stored at 4°C. The remaining plasma and RBC were recombined and immediately returned to the dog. The dog was then given 600 R total-body x irradiation, and one to three hr later the stored marrow cells were returned to the dog intravenously. In 15 control dogs, 500 R to the total body was 100% lethal. Of 19 marrow-treated animals, 14 survived, three died of irradiation sickness, one died of lobar pneumonia, and one of bacterial sepsis. All five control dogs died on the fourth to sixth postirradiation day of typical irradiation sickness. All 14 marrow-treated survivors also showed varying aspects of irradiation sickness, but in a moderate form. These dogs were anorexic from the fourth to the seventh day, and usually required parenteral fluids during this period. Most also had diarrhea of varying severity; but by the seventh day, the treated survivors were eating and diarrhea had ceased. Of the three treated animals which succumbed to irradiation illness, two received less than 5 billion cells in the returned buffy coat. The viability of the buffy coat cells used was uniformly good as measured with trypan blue vital staining. Viabilities of cells in the centrifuged buffy coat averaged 85%. When marrow was frozen in a solution of 12% dimethylsulfoxide for three days before irradiation and replacement, viability of the thawed marrow dropped to 60%. (BBB)

26129 POTENTIAL ANTIRADIATION DRUGS. I. AMIDE, HYDROXAMIC ACID, AND HYDRAZINE DERIVATIVES OF MERCAPTO ACIDS. AMINO THIOACIDS. Edward R. Atkinson, G. Richard Handrick, Robert J. Bruni, and Felix E. Granchelli (Arthur D. Little, Inc., Cambridge, Mass.). J. Med. Chem., 8: 29-33(Jan. 1965).

The syntheses and radioprotective properties of 25 compounds drawn from the title classes are described. All compounds containing a thiol function show some protective activity in either mice or bacteria. N,N'-bis-(mercaptoacetyl)hydrazine has promise as a radioprotective drug. (auth)

26130 REDUCTION OF RADIOSENSITIVITY OF ANTIBODY RESPONSE BY PRIOR ADMINISTRATION OF NON-CROSS-REACTING ANTIGEN. S. Muramatsu and Y. Sohmura (Kyoto Univ.). Nature, 206: 416-18(Apr. 24, 1965).

Studies were made on the effects of bovine serum albumin (BSA) on the radiosensitivity of immune response of bovine gamma globulin (BGG) in mice. The results showed

that retardation of the antibody response was caused by x irradiation. Fifteen days after injection of BSA, only those mice that were irradiated 5 days after immunization were found to be positive. When mice were bled after 20 days, the mice irradiated after immunization were positive; but the mice irradiated before or on the day of antigen administration were negative. The degree of radioresistance of antibody-forming mechanisms extended as the immune response proceeded. Lowering of radiosensitivity with the lapse of time following antigen injection was seen also in anti-BGG formation. The results suggest that the immune mechanism is evoked non-specifically in the early period of antibody response and such a non-specific event in immune response may be very radiosensitive. (P.C.H.)

26131 PROTECTION OF LYMPHOCYTES IN THE THYMUS OF X-IRRADIATED RATS BY CYSTEAMINE. Y. Tanaka and R. H. Rixon (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nature, 206: 418-19(Apr. 24, 1965).

The protective effects of cysteamine against radiation effects on the rat thymus were investigated using both tissue sections and smeared cell suspensions. A wide range of radiation exposures (200-3,000 R) were used. The results showed that cysteamine does have a protective effect against the early radioinduced pycnosis in thymus, particularly among the radiosensitive lymphocytes of the cortex. (P.C.H.)

26132 STUDIES ON THE EFFECT OF CAPE ALOE FOR IRRADIATION LEUCOPENIA. Momoe Soeda and Mieko Fujiwara (Japan Defence Agency). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 1109-1112(Dec. 1964). (In Japanese)

Findings obtained in the course of studies on prophylactic and therapeutic effects of aloetin and aloe B fraction on leucopenia induced by cobalt-60 irradiation are described. The therapeutic intravenous or subcutaneous administration of aloetin and aloe B fraction on five or seven consecutive days subsequent to whole-body irradiation by cobalt resulted in improving the WBC counts. (auth)

26133 PHARMACOLOGIC AND CLINICAL STUDY OF 2-AMINOETHYLISOTHIURONIUM BROMIDE HYDROBROMIDE: UTILIZATION IN THERAPEUTIC NEUROLOGY. Georges Akoun (Hopital Tenon, Paris). Psychiat. Neurol. Neurochir., 67: 278-88(May-June 1964). (In French)

The pharmacologic actions of the radioprotective drug 2-aminoethylisothiuronium (AET) are reviewed, with reference to 44 publications. Its use in a patient is described. The pharmacologic characteristics of AET are dominated by a mild hypertensive effect with peripheral and splanchnic vasodilation, bradycardia, and a considerable and consistent effect of causing hyperventilation. Experimentally it has been found to be a powerful aid in the rapid recuperation of cerebral function after interruption of the circulation and in the rapid cicatrization of cutaneous wounds, as well as against the ill-effects of ionizing radiations. It also has some radiomimetic effects; these effects are based on the contribution of SH groups to cellular oxidation–reduction reactions. Clinically, AET was shown to be effective against coma (traumatic, vascular or post-neurosurgical), neurological deficiency syndromes, and cutaneous disorders. It is administered by infusion at the rate of 1 to 2 g/24 hr. The local and general tolerance to it, as a rule, is good. Two contraindications are pregnancy and severe coronary disease. Reported instances of the use of AET in man are enumerated, and a detailed description of its effects in a comatose patient suffering from cranial injury is given. (BBB)

26134 MODIFICATION OF POSTIRRADIATION TAURINE EXCRETION BY CYSTEINE ADMINISTRATION. Roger Hewitt and Thomas R. Noonan (Univ. of Rochester, N. Y.). Radiation Res., 25: 9-14(May 1965).

The possibility that post-irradiation hypertaurinuria may be modified by the administration of a radioprotective drug prior to exposure was investigated. The results showed that the effects of a large dose of cysteine or radiation in causing elevated urinary taurine in the rat are not additive. The failure of summation of effects is not due to a diminution in the conversion of cysteine to taurine. The modification of radioinduced hypertaurinuria by radioprotective agents appears to be established. (P.C.H.)

26135 REPOPULATION OF BONE MARROW IN MICE: NUMBER AND TYPE OF CELLS REQUIRED FOR POST-X-IRRADIATION PROTECTION. N. B. Kurnick and Naime Nokay (Univ. of California, Los Angeles and Veterans Administration Hospital, Long Beach, Calif.). Radiation Res., 25: 53-67(May 1965).

Fractionation of cells from mouse bone marrow and autologous mouse spleen indicated that the cell responsible for bone marrow repopulation and x irradiation protection resembles the small lymphocyte. Experiments with injection of different numbers of bone marrow and spleen cells and observations on survival obtained by fractional irradiation of the entire body and of extirpation of the shielded spleen after irradiation indicate that approximately 3×10^4 cells of this type are required to provide 50% survival, and that approximately this number migrates from the shielded extremity or spleen of a mouse per hour (slightly faster for spleen and slower for bone marrow). (auth)

26136 CHANGES IN PERIPHERAL BLOOD OF RATS IRRADIATED IN A HYPOTHERMAL STATE. L. G. Kon'kova (Gor'kii State Univ., USSR). Radiobiologiya, 5: 198-201(1965). (In Russian)

Female white rats irradiated in a hypothermal state (rectal temperature 20 to 22°C) showed less decrease in blood total leukocyte count, absolute number of lymphocytes, and sharpness of hemoglobin decrease than those irradiated at normal temperatures. Neutrophil changes were unaffected by hypothermia. (IIC-M.G.)

26137 HISTOLOGICAL AND HISTOCHEMICAL INVESTIGATION OF THE RESTORATION OF REGENERATIVE ABILITY OF AXOLOTL EXTREMITIES BY X RADIATION. S. Ya. Tuchkova (Inst. of Animal Morphology, Academy of Sciences, USSR). Radiobiologiya, 5: 207-10 (1965). (In Russian)

A single local 8-kR x irradiation of axolotls suppressed regenerative morphological-development and organ-tissue-differentiation processes. Treatment of the irradiated animals with freshly prepared high-molecular RNA restored the ability of the tissues to differentiate, forming regenerated blastema cells. Further regeneration was slow compared to normal. (tr-auth)

26138 ELECTROPHYSIOLOGICAL CHANGES INDUCED BY IRRADIATION OF HEADS OF RABBITS FED ON A DIET WITH AMINAZINE. N. S. Delitsyna. Radiobiologiya, 5: 231-6(1965). (In Russian)

Feeding of aminazine to locally (head) irradiated rabbits somewhat decreased the effect of the irradiation. The lethal outcome was not usually prevented, but electrophysiological studies and changes in the time of death indicated less deep (also nonreversible) nerve center damage that develops with time since this occurs, for example with lower doses (1 kR). The data provide one more indication of damage to the neuro-humoral regulation at the hypothalamus-pituitary level in irradiated animals. (tr-auth)

26139 RADIOPROTECTIVE ACTION OF INERT GASES AND LOW-MOLECULAR NARCOTICS. III. INVESTIGATION OF RADIOPROTECTIVE ACTION OF COMPRESSED NITROGEN. V. S. Kal'nii (Inst. of Cytology, Leningrad). Radiobiologiya, 5: 287-92(1965). (In Russian)

Treatment of bean seedlings with cupferron (40 μmoles) decreased the antiradiation effect of compressed nitrogen (2, 1, or 0.2%) added to air (mixtures of 2, 1, or 0.2% oxygen and nitrogen). The data agree with the diffusion rather than the adsorption theory of the protective action of compressed nitrogen. (tr-auth)

26140 PROTECTIVE EFFECTS OF S-β-AMINOETHYLISOTHIOURIA BROMIDE ON T2 PHAGE. I. M. Gabrilovich and A. F. Seleznev (Belorussian State Univ., Minsk). Radiobiologiya, 5: 314-15(1965). (In Russian)

Within the gamma dose range 10^4 to 10^5 R, AET had a protective effect on phage T2. (tr-auth)

26141 INFLUENCE OF RADIOSENSITIZERS AND RADIOPROTECTERS ON THE RESPONSE OF CANCERS TO RADIOTHERAPY. J. R. Maisin (Centre d'Etudes de l'Energie Nucleaire, Mol, Belg.). Rev. Franc. Etudes Clin. Biol., 9: 437-55(1964). (BLG-305). (In Italian)

A review is presented on the effects of radioprotective compounds on the response of cancers to radiotherapy. 167 references are included. (P.C.H.)

26142 CYTOGENETIC PROOF OF THE GRAFT OF BONE MARROW CELLS IN MICE. S. Sorieul (Hopital Saint-Louis, Paris). Rev. Franc. Etudes Clin. Biol., 9: 423-4(Apr. 1964). (In French)

It is possible to distinguish between male and female mouse cells because the x chromosome is much longer than the y chromosome. On the basis of this fact, three-month-old female mice, 12 C_3H and 24 F_1 ($C_{57}Bl_6 \times DBA/2$), were x irradiated with 950 R and injected with 2×10^7 bone marrow cells from male C_3H mice. The female mice were killed periodically after an intraperitoneal injection of 0.2 ml of a 0.003% isotonic colchicine solution. The bone marrow was placed in a 1.0% sodium citrate solution and a karyologic study made of the cells in mitosis. Male cells, distinguished by the single x and y chromosomes, were present in both types of female mice. That is, the male marrow cells divided spontaneously both as an isogenic (in the C_3H) and an allogenic (in the F_1 ($C_{57}Bl_6 \times DBA/_2$)) graft. The proportion of cells in mitosis was much larger in the female marrow examined shortly after grafting. The smaller number of mitotic cells in the marrow of mice killed later often corresponded with the mouse being in a secondary syndrome. No cells belonging to the female host were found. The results confirm those obtained with other mammals, but have the advantage of being done on animals with known immunological characteristics. Thus it was unnecessary to utilize translocations or other chromosomic anomalies to verify the results. (BBB)

26143 THE EFFECT OF LEUCOCYTIC RESTORATION OF DEOXYRIBONUCLEIC ACID INJECTED IN SWISS MICE AFTER IRRADIATION WITH 700 RADS. THE INFLUENCE OF PRIOR INGESTION OF 2-AMINOETHYLISOTHIURONIUM (AET) AND THIOGEL. C. Paoletti, J.-P. Rebiere, G. Aubin, and M. Tubiana (Institut Gustave-Roussy, Villejuif, France). Rev. Franc. Etudes Clin. Biol., 9: 950-5 (Nov. 1964). (In French)

After irradiation, hematopoietic and intestinal disturbances appear in mice, obscuring any restorative effect of DNA. To minimize these disturbances a radioprotector, 2-aminoethylisothiuronium (AET) in thiogel, was administered to some mice before x ray treatment with 700 Rad. The DNA used was obtained from calf thymus. Two series of tests were run on seven lots of 20 mice each: a) ingestion of AET-thiogel + 700 Rad + intraperitoneal injection of one ml 0.15 M NaCl; b) AET-thiogel + 700 Rad + injection of one mg DNA in 0.15 M NaCl; c) 700 Rad + DNA in 0.15 M NaCl; d) 700 Rad + 0.15 M NaCl; e) no irradiation + AET-thiogel + DNA; f) no irradiation + DNA; g) no irradiation + AET-thiogel + 0.15 M NaCl. All injections were given daily for five days. In groups e, f, and g, without irradiation, the variation in weight and leucocyte count was minimal. In all irradiated groups the leucocyte count dropped 75% or more by the fifth day. In groups c and d there was weight loss comparable to that in unprotected irradiated mice. In group c the leucocyte count never returned to 50% of normal and most of the mice were dead by the 16th day. In group d there was no significant leucocytic restoration and most were dead by the 14th day. In group a, with the radioprotector, the leucocyte count fell about 90% by the fifth day, then increased to the 40th day, but never returned to normal. Group a lost weight to the 14th day, then began to regain it. After 40 days only five of 40 mice survived in group a. In group b, with the radioprotector and DNA, the leucocyte count did not decrease as much as the other groups, and a normal count was regained by the 25th day. Group b lost weight until the 14th day, but returned to normal by the 30th. At the end of 40 days, 11 of 40 mice survived in group b. The mechanism of radiorestoration by DNA remains unknown. (BBB)

26144 THE EFFECT OF HYPOXIA ON A SECOND GRAFT OF HOMOLOGOUS BONE MARROW IN PREVIOUSLY IRRADIATED AND GRAFTED MICE. G. Mazzella (Centro di Studi e Ricerche di Medicina Aeronautica e Spaziale, Rome). Riv. Med. Aeron. Spaziale, 27: 353-64(July-Sept. 1964). (In Italian)

Since there was a high percentage of survival in groups of C 57 BL mice in a previous experiment, in which they had been irradiated in both air and under conditions of hypoxia and subsequently received a graft of homologous bone marrow, attempts were made to ascertain to what extent the survivors would be able to withstand a further pan-irradiation and a second graft of homologous bone marrow, under the same experimental conditions as the first time. After 253 days from the first experiment, irradiation with 930 R units of ^{60}Co was effected in a single dose, while having two groups of mice breathe air (the control group and the group that was subsequently to receive a graft) and other two groups of mice breathe 5.6% O_2 (a control group and another to be grafted). After 150 days from the application of the second treatment, the only survivors were: 20% of the control group irradiated while breathing air; 0% of the re-grafted after re-irradiation in air; 100% of the mice re-irradiated while breathing 5.6% O_2; and 57% of the mice re-grafted after re-irradiation under 5.6% O_2. The reason for the behavior of some of the data considered are discussed, in addition to survival, weight, and some hematological values. (auth)

26145 HISTOLOGICAL CHANGES IN SOME ORGANS OF MICE TWICE IRRADIATED WITH Co^{60} AND GRAFTED WITH HOMOLOGOUS BONE MARROW. G. Mazzella and G. Paolucci (Centro di Studi e Ricerche di Medicina Aeronautica e Spaziale, Rome). Riv. Med. Aeron. Spaziale, 27: 467-83(Oct.-Dec. 1964). (In Italian)

Histological studies were made on preparations from mice, irradiated in open air or in anoxia, and subsequently grafted with homologous bone marrow. The mice were distributed in 5 groups, and the treatment was repeated in a few of them. The mice deceased spontaneously at different times. The organs examined were liver, spleen, and bone marrow. Changes were found in groups irradiated and grafted one and two times, compared to only irradiated groups. These changes were studied and supported by iconographical documents. The research stresses belated results, namely those obtained approximately one year after irradiation. Conspicuous histological changes were observed in irradiated and grafted animals, whereas only poor changes were observed in animals grafted, once or several times, in open air or in anoxia. (auth)

26146 RADIOBIOLOGICAL INVESTIGATIONS OF THE T5-RECEPTOR. Felicitas Bohne (Kernforschungszentrum, Karlsruhe, Ger.). Strahlentherapie, 126: 565-89 (Apr. 1965). (In German)

The inactivation of the T5-receptors was investigated by means of soft x rays and γ rays, and its dependence upon the kind of medium of suspension, the oxygen concentration, and the presence of sulfur-containing substances. It was observed that under irradiation in buffer the inactivation is primarily due to indirect effects, i.e., through products of water radiolysis. A decrease of the inactivation rate under irradiation with high linear energy transfer, and the absence of the influence of oxygen points to the probability that the primary radical $H^{\cdot}$, $OH^{\cdot}$, and H_2O^- are the inactivating agents. During irradiation in broth (and in similar media) damage is mainly due to direct radiation effects. If cysteamine or hydrogensulfide are present during irradiation in buffer, the inactivation-dose is increased approximately 10 fold; in this case the protective effect of the SH-substances is attributed to their capacity as radical scavenger. The protective effect of cysteamine in the case of primarily direct action of radiation is considerably weaker and is attributed to the properties of the SH-substances as H-donators. It was found for the first time that cystamine gives far stronger protection than cysteamine. (auth)

26147 THE EFFECTS OF ANAPHYLATOXIN AFTER LETHAL WHOLE-BODY IRRADIATION. Eduard Gabler and

Wilhelm Stoeckl (Tierarztliche Hochschule, Vienna). Strahlentherapie, 126: 590-4(Apr. 1965). (In German)

Anaphylatoxin protected against lethal whole-body irradiation with x rays. Subcutaneous administration of anaphylatoxin, prepared from the serum of guinea pigs (albino-rats), about 15 min after lethal exposure resulted in a survival rate of 36% in albino rats (51.0% in guinea pigs). (auth)

26148 ON THE INFLUENCE OF ERYTHROPOIETIN ON THE EFFECTIVENESS OF BONE MARROW TRANSPLANTATION IN ACUTE RADIATION SICKNESS. Dimiter G. Zographov and Ilia A. Baev (Forschungsinstitut fur Radiologie und Strahlenhygiene, Sofia). Strahlentherapie, 126: 595-600(Apr. 1965). (In German)

Preliminary results of an investigation of erythropoietin upon the effectiveness of bone marrow transplantation after supralethal whole-body x-irradiation are reported. Pure erythropoietin, administered intraperitoneally in doses of 14 cobalt units on the 4th, 6th, and 7th day after irradiation increases the survival rate in male Wistar rats after homologous bone marrow transplantation from 33% to 66% ($p = 0.01$). The use of only erythropoietin after irradiation did not influence the survival rate. Thus, the broader erythropoietic potential produced by bone marrow transplantation is necessary for a favorable effect of erythropoietin. (auth)

26149 ON THE RADIOSENSITIZING EFFECT OF SOME NATURALLY OCCURRING PYRIMIDINES. R. I. Pol'kina (Inst. of Oncology, Leningrad). Vopr. Onkol., 11: No. 3, 57-8(1965). (In Russian)

Cytosine, thymine, and uracil were tested as possible radiosensitizers in mice bearing subcutaneously transplanted Ehrlich tumor. Only uracil administered before the irradiation proved to be a sensitizer for the tumor cells to the effect of x rays. Cytosine and thymine had no radiosensitizing action. (auth)

26150 SULFHYDRYL-DISULFIDE PROTECTION MECHANISMS AND THE ISOLATION OF A POSSIBLE TARGET STRUCTURE FROM MAMMALIAN CELL NUCLEI. Lorentz Eldjarn (Univ. of Oslo). p.305-28 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

A review is given of the mechanisms which are under surveillance as explanation for the in vivo protection by the compounds of the cysteine-cysteamine group. A radiochemical explanation appears to be the more likely. The mixed disulfide theory is discussed. Examples are given of impressive protection factors when essential SH groups are temporarily covered by cysteamine residues bound as mixed disulfides. Knowledge of the organ and cellular distribution of the S-containing agents is summarized. It seems justifiable to conclude that these agents demonstrate a favorable localization in cells and tissues of particular significance in the development of the radiation syndrome. The protective agents are effectively reduced to their SH form by erythrocytes, by the glutathione reductase system of most cells and tissues, as well as by actively metabolizing mitochondria. Intracellularly, the free protective residues, for the greater part exist in SH form, although a certain amount of the disulfide forms may exist in particular tissues due to difference in the Michaelis-Menten constant of glutathione reductase for GSSG. At least 30 to 50 percent of the protective residues are attached to protein fractions of subcellular structures, for a greater part in the form of mixed disulfides. A particularly high concentration of the protective residues are found in the cell nuclei. Upon incubation of isolated liver and thymus nuclei with cysteamine, an extensive mixed disulfide fixation to the nucleoprotein fraction was found to occur. Some results of our attempts to isolate and characterize SH/SS proteins of cell nuclei are presented. For this purpose an organomercurial polysaccharide chromatographic material was developed. (auth)

26151 THE INFLUENCE OF OXYGEN ON DAMAGE TO THE PROLIFERATIVE CAPACITY OF CULTURED HUMAN CELLS PRODUCED BY RADIATIONS OF DIFFERENT LET. G. W. Barendsen (Radiobiological Inst. TNO, Rijswijk, Netherlands). p.331-5 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Fundamental aspects of the differences in oxygen enhancement ratio (OER) between high and low LET radiations are presented. Studies were performed on an established line of human kidney cells in culture. A quantitative determination of the fraction of cells which after irradiation retained the capacity for clone formation were plotted as a function of the dose to give survival curves for ^{210}Po alpha particles and 250 kvp x rays. (H.G.D.)

26152 THE EFFECT OF CYSTEINE UPON THE RADIATION SENSITIVITY OF LYSOZYME AT TWO TEMPERATURES AND T2 BACTERIOPHAGE AT VARIOUS LET. Robert J. Shalek, Charles E. Smith, S. J. Sedita, and Peter Almond (Univ. of Texas, Houston and Rice Univ., Houston, Tex.). p.336-9 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

A summary of the effect of cysteine upon the radiation sensitivity of T2r bacteriophage and lysozyme under several physical conditions of irradiation is presented. (auth)

26153 OXYGEN, NITROGEN, RECOVERY, AND RADIATION THERAPY. M. M. Elkind, R. W. Swain, T. Alescio, H. Sutton, and W. B. Moses (National Cancer Inst., Bethesda, Md.). p.442-66 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Findings on the survival dependence on oxygen of mammalian cells (Chinese hamster cell line V79-379-A) subjected to fractionated x-ray exposures are reported. The effects of reduced oxygen tension on the growth and division properties of mammalian cells are discussed; the fractionation response of cells equilibrated with air is reviewed; and the survival kinetics of cells exposed to fractionated doses is compared for nitrogen and air. A model for tumor response to fractionated doses in radiotherapy is presented. (H.G.D.)

26154 THE INTEGRITY OF CYTOPLASMIC ULTRASTRUCTURES: A FACTOR IN CELLULAR RADIOSENSITIVITY. Anna Goldfeder (Dept. of Hospitals, New York and New York Univ., New York). p.539-46 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

The relationship between cellular structure, function, and radiosensitivity was studied in two types of malignant mouse tumors, a slowly growing epithelial tumor and a rapidly growing spindle-cell type. Structural properties of cells from lymph nodes of normal, nonirradiated, and whole-body x-irradiated mice were studied electron microscopically for comparative purposes. The cytoplasmic components noted in both types of tumors as well as in the cells of the lymph nodes included: mitochondria, Golgi apparatus, centrioles, membranes and vesicles of the endoplasmic reticulum, and ribonucleoprotein particles. The activities of two enzyme systems, catalase and ATPase, were determined in both types of tumors. Morphologic alterations in cytoplasmic organelles induced by irradiation are: swelling of mitochondria and loss of their internal membranes; change in permeability of the boundary membranes as revealed by the release of enzymes; dilatation of the vesicles of the endoplasmic reticulum; breakages in the plasma membrane; and in some cases, aggregation of the ribonucleoprotein particles. It was concluded that the integrity and quantity of the cytoplasmic composition that pertain particularly to the intrinsic membrane system may be determining factors in cellular radiosensitivity. (H.G.D.)

26155 CLINICAL POTENTIALITIES OF RECENT ADVANCES IN CELLULAR RADIOBIOLOGY. Henry S. Kaplan (Stanford Univ., Palo Alto, Calif.). p.584-98 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Problems are discussed concerning clinical application of: differential chemical radiosensitization; differential chemical radioprotection; and cell cycle-modulated dose fractionation. Advantages and limitations of each method are presented. (H.G.D.)

Radiation Hazards and Protection

See also HEALTH AND SAFETY.

Refer also to abstract 26611.

26156 (AERE-R-4736) THE LOGNORMAL DISTRIBUTION AND SOME EXAMPLES OF ITS APPLICATION IN THE FIELD OF RADIATION PROTECTION. H. J. Gale (Atomic Energy Research Establishment, Harwell (England)). Mar. 1965. 29p. Dep.; $1.00(BIS), 5s.(HMSO).

The properties of the simple log normal distribution and methods of estimating its parameters from a set of experimental results are described and illustrated with examples from the field of radiation protection. Extensions of the distribution to more complicated cases are mentioned. Discussion of the relevant details of the normal distribution and of sampling theory is included. Consideration of the use of the distribution is recommended for experimental data which are asymmetrically distributed. (auth)

26157 SOME PROBLEMS OF RADIATION PROTECTION IN THE GYNECOLOGICAL BRACHYCURIE THERAPY. Endre Kuhn and Gabor Keller (Univ. of Pecs, Hungary). Orv. Hetilap, 105: 2427-9(Dec. 20, 1964).

Measurements were made in a ward equipped with modern installations for radiation protection, in which gynecological brachycurie therapy is performed. It was concluded that the purposeful alteration of radioactive devices and the mode of their application, and the detailed planning and organization of the location of radioactive patients, their nursing care and that of the technique used can decrease the radiation load received by the personnel considerably. Only in this manner can a reduced level of radiation exposure to the personnel involved in treatment and nursing be achieved. A stand is made against the rotation of personnel and the employment of young nurses who do not yet have children. (CFSTI)

26158 CONSIDERATIONS ON RADIOLOGICAL PROTECTION. S. Lin (Ospedali Riuniti, Trieste). Radiol. Med., 51: 67-72(Jan. 1965). (In Italian)

After discussing the threshold dose problem in the concept of radiation damage, the contribution given to the solution of health physics questions not only by physicists but also by doctors, chemists, biologists, and hygienists is emphasized. It is hoped that restrictions will be placed on the indiscriminate use of radiological diagnosis, so as to maintain any possible genetic risks for large numbers of the population at the lowest praticable level and that an increasingly sincere and active cooperation will develop between doctors and physicists in creating a protectionist conscience also in the population. (P.C.H.)

26159 THE ENDOCRINE GLANDS IN EXPERIMENTAL RADIATION SYNDROME. II. HORMONE FRACTIONS IN THE PATHOGENESIS OF THE RADIATION SYNDROME. J. Comsa (Universitat des Saarlandes, Homburg, Ger.). Strahlentherapie, 126: 541-64(Apr. 1965). (In German)

The consequences of different mutilations of the endocrine apparatus upon radioresistance are reviewed. It was concluded that: hypophysectomy decreases the time of survival; thyroidectomy has no direct influence on the survival, but modifies the development of some signs of the radiosyndrome; adrenalectomy decreases the time of survival, but several consequences of irradiation are suppressed in adrenalectomized animals; and castration increases the time of survival. The ways and means of biological radioprotection, such as parabiosis of irradiated animals with normal animals, implantation of normal tissues, principally hematopoietic tissues, and injection of purified hormones are also reviewed. The conditions of the radioprotective influence of hormones were found to be different from one hormone to another. These differences are listed. (P.C.H.)

Radiotherapy and Radiodiagnosis

Refer also to abstracts 26666 and 26719.

26160 (ORINS-49(p.72-8)) THERAPY WITH RADIATION. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.).

The effects of pretreatment with thyrotropic hormone (TSH) on ^{131}I metabolism in malignant thyroid tissue were studied in 11 patients with histologically proved thyroid cancer. Results indicate that TSH pretreatment makes ^{131}I therapy more effective in some patients with thyroid carcinoma. (C.H.)

26161 (ORINS-49(p.79-97)) RADIOISOTOPES IN DIAGNOSIS. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.).

Progress is reported in the development of diagnostic procedures using radioisotopes. Results are reported from studies on the distribution of ^{68}Ga in the skeleton of rats. Data are presented on the use of colloidal ^{198}Au and external counting to determine the distribution of functioning bone marrow in 27 patients. A series of 40 studies in 18 patients with thyroid carcinoma indicated that ^{130}I is adequate for most diagnostic procedures and is a useful isotope to evaluate the responses of normal, hyperthyroid, and thyroid carcinoma patients to various drugs. (C.H.)

26162 (ORINS-49(p.98-110)) ABSORPTION, WHOLE-BODY, AND ORGAN RETENTION OF BIOLOGICALLY IMPORTANT RADIOISOTOPIC MATERIALS. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.).

The calibration of a whole-body γ counting facility is discussed. Applications of the facility in the evaluation of thyroid function in infants after the administration of tracer dose of ^{131}I are described. A study was made of the radioactivity of 14 brands of cigarettes and some variations were found. Preliminary studies on 120 normal adult men counted with the whole-body counter showed no difference in whole-body activity between smokers and nonsmokers. Results are reported from estimations of ^{239}Pu content in samples of tissue and bone in a thumb and finger amputated after an accident that resulted in a Pu contaminated wound. The use of an arm counter in blood volume studies, using ^{51}Cr and ^{131}I human serum albumin as tracers, is reported. (C.H.)

26163 UNILATERAL ADRENALECTOMY FOLLOWED BY PITUITARY IRRADIATION IN CUSHING'S DISEASE: WITH OBSERVATIONS ON CORTISOL SECRETION AFTER THERAPY. A. P. van Seters, M. Jenny, and A. Querido (Academisch Ziekenhuis, Leiden). Acta Endocrinol., 48: 253-62(1965).

After the diagnosis of hyperadrenocorticism was established, unilateral adrenalectomy followed by pituitary irradiation, within 3 weeks after operation, was done. Usually a total tissue dose of 3000 R was administered over 3 to 4 weeks. In 19 patients of the 38 patients studied, this therapeutic procedure was followed by a complete remission as judged from the clinical improvement and reduced excretion of steroid metabolites. Cortisol secretion rates were measured by isotope dilution following the intravenous injection of approximately 0.9 μC ^{14}C-cortisol. Determinations of cortisol secretion performed in 13 patients showed that in 11 patients, the secretion rates varied between 12.4 and 30.9 mg/24 hr, values which are considered normal. The question is discussed whether the observed clinical improvement results from a spontaneous remission, the effect of irradiation alone, the effect of unilateral adrenalectomy, or from the combination of these two latter forms of treatment. Earlier reports on the effect of pituitary irradiation in Cushing's disease, from as early as 1936, vary in their conclusions on the favorable effect of this teatment. They are interpreted from a standpoint of dosage and duration of treatment. Thus pituitary irradiation of 3800 to 4000 R in 14 patients resulted in 7 complete remissions ranging in duration from 6 to 14 years. In the present series, unilateral adrenalectomy in five patients, as the only treatment, was followed by a remission in only two instances, and both patients had a recurrence of their disease after one to 2 yr. It is concluded that the combination of pituitary irradiation and unilateral adrenalectomy is a superior treatment. (BBB)

26164 EVALUATION OF VASOACTIVE DRUGS WITH CLEARANCE OF RADIOSODIUM. Eduardo Valdes, Herman Garcia del Rio, Vitorio Pecorini, and Hector Gotta (Univ. of Buenos Aires). Angiology, 15: 431-3(Oct. 1964).

Use of ^{22}Na to measure local circulatory action of drugs is described and applied to 12 normal subjects and 20 patients with vascular disease. Tissue clearance, or local disappearance, of subcutaneously injected ^{22}Na was measured. Tissue clearance was determined by the following method: 0.1 ml of an isotonic solution of ^{22}Na with an activity of 2 μC was injected in the subdermis of the anterior part of the leg. The radioactive papule was then monitored by means of a scintillation counter. In each case the test was performed before and 20 min after injection of the drug, in the same place and on different days. The results of the test were expressed in $t_{\frac{1}{2}}$ values, that is, the time taken by radioactivity to decay to half its initial value. Decrease in $t_{\frac{1}{2}}$ value after injection of the drug is evidence of an acceleration of the reabsorption of ^{22}Na, which shows an increase in blood flow. Averages expressed in percentage of decrease of $t_{\frac{1}{2}}$ values were as follows in normal subjects: butylsympatol, 41%; Regitine, 38%; acetylcholine, 37%; and Priscol, 25%. In the group of patients with arteriopathies, the results reflect a decrease in $t_{\frac{1}{2}}$ after the action of these drugs as follows: butylsympatol, 35%; Regitine, 29%; Priscol, 26%; and acetylcholine, 13%. Butylsympatol, when administered orally, produced in 10 cases a shortening of the $t_{\frac{1}{2}}$ by 35%, thus proving its therapeutic value. It is pointed out that even though subdermal clearance with radiosodium gives information on the peripheral dermal flow, the results cannot be generalized and applied to muscle. (BBB)

26165 INDIRECT ROENTGEN THERAPY IN HERPETIC KERATITIS THROUGH IRRADIATION OF THE TROPHOSENSITIVE OCULAR INNERVATION CENTERS. G. Sanna and G. Serantini (Ospedale Civile, Cesenna, Italy). Ann. Ottalmol. Clin. Oculist., 90: 1-13(Jan. 1964). (In Italian)

Radiobiologic aspects of irradiation of neural tissue were studied in 23 patients suffering from herpes keratitis whose ages varied from age five to 77 yr. The patients were treated with a total dose of 600 R of 160-kv x rays fractionated in doses of 100 R and given on alternate days over a cutaneous field of 6 × 8 cm. The patients showed the following symptoms: perikeratotic reactions, small superficial grayish ulcers, intense and deep conjunctival reactions, disk-shaped infiltrations in the corneal center, and iridal congestion. The patients received radiotherapy to the gasserian ganglion and ciliary ganglion. In many patients corneal sensitivity was entirely destroyed; the intraocular pressure was normal in 14 patients, increased in eight, and diminished in one. Eleven patients had previously been affected with herpetic keratitis in the same eye, and some were recurring cases. In 17 patients the radiotherapy was combined with medication, while six patients with superficial disease received only radiotherapy. Concerning the results obtained, in ten cases complete healing of the corneal lesion was observed, while in four other cases a residual corneal leucoma was observed following healing. In the remaining cases a considerable reduction of the ulcerative lesion with complete remission of the subjective symptomatology was observed. Only in one patient was the therapy unsuccessful. The patients who obtained complete restoration of corneal function were all affected with superficial herpetic disease, and at the end of the treatment the corneal membrane appeared to be fully recovered. In all patients the following results were observed: alleviation of the pain beginning with the first irradiation sessions, normalization of the intraocular pressure, disappearance and considerable alleviation of the concomitant uveitis. The patients who were treated exclusively with radiotherapy showed no substantial differences in comparison to patients treated with radiotherapy in combination with other medication, and this seems to demonstrate that the cumulative results obtained are mostly as a result of the radiotherapy. The radiobiological effects upon the gasserian and ciliary ganglia could be explained as a stimulating action and general activation of the circulatory metabolic conditions in ocular tissue with subsequent stimulation of its restorative activity. The radiotherapy also potentiated the phagocytic activity. It is emphasized that with this technique the ocular globe is completely protected from this radiation while its tissues receive the same beneficial results which could be obtained through direct radiotherapy. (BBB)

26166 RADIOISOTOPES IN RENAL DISEASE. P. M. Ronai (Univ. of Sydney). Bull. Postgrad. Comm. Med., Univ. Sydney, 20: 16-19(Apr. 1964).

Radioisotopic investigations of renal function are discussed in terms of two broad categories; those depending on temporal variation of isotope concentration, and those depending on spatial variation of isotopic concentration. The function of each kidney may be monitored externally following the ultravenous injection of radioactive substances, the most commonly being Hippuran labeled with ^{131}I. The equipment needed is complex and cumbersome, since heavy lead shielding of the detectors is required for the crystal to see only the kidney region and to reduce the effect of scattered radiation. The recent introduction of ^{125}I-Hippuran has made possible a great reduction in the thickness of shielding required, as this isotope is a very soft γ emitter. Thin crystals as small as 0.5 × 0.1 in. are efficient detectors of such low-energy radiation and, at the same time, background counts with these tiny crystals are low. Thus a small dose of isotope is possible. Following the injection of 5 to 8 μC of ^{131}I-Hippuran or 1 to 2 μC of ^{125}I-Hippuran, the renogram is determined. The renogram can only give an assessment of the overall function of each kidney. Scan appearances overlap, and the form of the scan is not always diagnostic of the underlying pathology. One of the commonest causes of an abnormal scan is incorrect positioning of the probes. In the second category of tests, those depending on spatial variation, are the ureterogram and the renal scan. The first is a means of detecting ureteric reflux. Five μC of ^{131}I serum albumin or ^{131}I-rose bengal is passed through a catheter into the bladder, and activity over the renal pelves is monitored by a set-up similar to that employed for the renogram. Any reflux of the isotope up the ureter is detected by a sudden increase in activity above background in the region of the renal pelves. The renal scan depends on spatial rather than temporal variation in isotope concentration; only one detector is used and it is moved backwards and forwards across the patient. The isotope used is a mercurial diuretic Chlormerodrin (Neohydrin) labeled with ^{203}Hg. Scanning is commenced one to three hr after injection of 150 μC and takes about half an hr. At present, resolution is about 1.5 cm, but smaller abnormalities may be detected by the use of ^{57}Co-Versenate. (BBB)

26167 RADIO-ACTIVE ISOTOPES IN THE INVESTIGATION OF THE ANEMIC PATIENT. R. W. Beal (Royal Prince Alfred Hospital, Sydney). Bull. Postgrad. Comm. Med., Univ. Sydney, 20: 29-38(Apr. 1964).

The use of ^{3}H, ^{14}C, ^{32}P, ^{51}Cr, ^{58}Co, ^{59}Fe, and ^{131}I as labels in diagnostic hematologic studies is reviewed. In deciding to study an anemic patient with radioisotopes, three factors should be considered: the patient, isotope, and equipment available. The isotope studies described seldom inconvenience a patient physically and present little radiation risk, but may require considerable time (up to two weeks). The isotope employed should be readily available, easily counted, and detectable in tracer quantities. The half-life of the isotope should be reasonably short. As equipment, a well counter and scaler are essential, and a mobile probe useful. The isotopes' physical and biological characteristics and the data obtainable from them are enumerated, and their application to specific groups of anemias discussed. Red-cell survival using ^{51}Cr-labeled red cells is one of the commonest and simplest radioisotope techniques. The patient's own cells or compatible donor cells, are incubated with 50–150 μC. Of the iron isotopes generally used, ^{59}Fe has a much shorter half-life than ^{55}Fe, 45 days compared with four yr. It has three β peaks and three γ peaks, which make it possible to count ^{59}Fe simultaneously with another isotope such

as ^{51}Cr. Radioiron may be given in the oral form, as a dilute solution containing 5 μC of ^{59}Fe and 5 mg of the appropriate Fe salt. When given intravenously, 10 μC is incubated with normal plasma before injection. Cobalt-58, prepared as ^{58}Co-labeled vitamin B_{12} (one molecule ^{58}Co in one molecule of vitamin B_{12}) is preferred to ^{60}Co because of the shorter half-life of ^{58}Co, 71 days compared with 5½ yr. Iodine-131 in the form of radioiodinated human serum albumin (RISA) is used to measure total blood volume. A known amount of RISA, with known and measured radioactivity is injected intravenously and, after allowing for complete circulation, a sample of blood is collected, the radioactivity determined and, from this, the dilution calculated. Blood volume is then determined. Phosphorus-32 can be used as an erythrocyte label and incorporated either in vitro or in vivo. It was the first isotope used to label the erythrocyte, but other safer, more satisfactory methods are in use. Carbon-14 is used as a glycine label, which is then incorporated into the erythrocytes being made by the marrow. The chief disadvantage is its long isotope half-life of 5760 years. Tritiated folic acid is used to follow the urinary excretion of folic acid following oral administration as a measure of its absorption. It is concluded that in many anemic states, valuable information may be obtained from isotope studies. (BBB)

26168 POSTRADIATION SARCOMA OF BONE. German C. Steiner (Hospital for Joint Diseases, New York). Cancer, 18: 603-12(May 1965).

Twelve cases of postradiation sarcoma are reported. The irradiation was given for a bone tumor in 10 instances, for a giant-cell tumor in 5 cases, for a benign chondroblastoma in one case, for a solitary bone cyst in one case, for a fibrous dysplasia in one case, for an eosinophilic granuloma (?) in one case, and for a primary reticulum cell sarcoma of bone in one case. In 2 instances (scapula, ilium) the sarcoma developed in previously normal bones which were in the field that was being irradiated. The age of the patients at the time of the development of the sarcoma ranged from 6 to 68 years. The time interval between irradiation and the appearance of the sarcoma in the various cases was 4 years to 30 years. In all the cases the sarcoma was examined histologically and in the majority there was evidence that the tumor was a bone-forming sarcoma, at least in part. In the cases in which the amount of radiotherapy was known the tumor dosage ranged from 3,600 to 6,300 R. It was concluded that once a sarcoma has appeared in an irradiated bone, the possibility of survival is minimal even if the affected part is amputated promptly. (P.C.H.)

26169 EXTRASKELETAL OSTEOGENIC SARCOMA. A LATE COMPLICATION OF RADIATION THERAPY. Carl W. Boyer, Jr. and James J. Navin (USA Tripler General Hospital, San Francisco). Cancer, 18: 628-33 (May 1965).

Two cases of an extremely rare occurrence of extraskeletal osteogenic sarcoma as a late complication of radiotherapy are reported. Although extremely rare, post-irradiation osteogenic sarcoma does occur in the soft tissues. Evidence of severe chronic radiodermatitis in the tumor area is a necessary prerequisite to the diagnosis and there is a latent period of a variable number of years between irradiation and the appearance of the tumor. The ultimate prognosis remains quite dismal. (P.C.H.)

26170 THE RADIOACTIVE ROSE BENGAL TEST; ITS VALUE IN THE DIAGNOSIS OF EXTRAHEPATIC BILIARY ATRESIA IN YOUNG INFANTS. Frederick B. Becker and Dennis F. Hoeffler (U. S. Naval Hospital, Portsmouth, Va.). Clin. Pediatr. (Philadelphia), 3: 714-17(Dec. 1964).

The practicality and accuracy of the radioactive rose bengal test was evaluated in three infants. The test appears to be accurate, safe, and practical as a method of differentiation. The accuracy of the test was confirmed by the operative findings in the three cases, and by the return to normal excretion in one patient in whom surgical repair was possible. (P.C.H.)

26171 IRRADIATION OF CANCER OF THE RECTUM AND RECTOSIGMOID. Walter T. Murphy and Leonidas Castro (Buffalo General Hospital). Diseases Colon Rectum, 7: 102-5(Mar.-Apr. 1964).

Indications for, dose factors, radiosensitivity considerations, complications, and beneficial results of external irradiation are presented with reference to 135 patients. Irradiation was given for postoperative pelvic recurrence, inoperability or refusal to accept surgery, as a routine postoperative or preoperative procedure. Adenocarcinoma of the rectum and rectosigmoid is not very responsive to irradiation. However, many carcinomas show remarkable regression of neoplastic bulk after administration of moderate amounts of radiation. Occasionally, a primary lesion is totally eradicated by intensive irradiation. The curability rate after irradiation is low because of the poor tolerance of normal tissues of the rectal and rectosigmoidal regions, often further reduced by infection, and because of the difficulty of delineating the limits of involvement of the lymphatic field. Therefore, delivery of irradiation doses sufficient to completely destroy an adenocarcinoma is intolerable and often dangerous. Eighteen patients underwent only irradiation by multiple converging pelvic x-ray beam technic. In most, only palliative irradiation was indicated and attempted, the total tumor site dose ranging from 2000 to 6000 Rad delivered within two to seven weeks. Irradiation may produce changes that make it possible to postpone or avoid colostomy. However, colostomy should be performed before irradiation when an extensive neoplasm is causing serious obstruction. Irradiation was followed by abdominoperineal resection in four patients. The incidence of peritonitis and delayed wound healing due to infection was less in patients who had received preoperative irradiation. Probably some of the success was due to the anti-inflammatory effect of the moderate irradiation dosage. Preoperative irradiation with a tolerable time dose relation does not create or increase surgical difficulty nor postoperative morbidity. Irradiation of recurrent pelvic carcinoma is most difficult, but is sometimes rewarding as a palliative measure. Of the 107 such patients, 26 had relief of pain or regression of a deep pelvic or perineal mass for periods up to four months. In only six patients was pain relieved longer than one year, while no such relief was experienced by 58 patients. It is concluded that many cancers of the rectum or rectosigmoid may be palliated by irradiation. Relief of pain and tenesmus, decrease in bleeding and discharge, shrinkage of tumor, and avoidance or postponement of colostomy can often be achieved. (BBB)

26172 PHYSICAL AND TECHNICAL POSSIBILITIES FOR THE IMPROVEMENT OF X-RAY IMAGE INTENSIFICATION. M. Keller (Zentralabteilung Strahlenschutz der Kernforschungsanlage, Julich, Ger.). Elektromed. Ihre Grenzg., 9: 1-12(Mar. 1964). (In German)

The quantum noise effect limits the sensitivity of an x-ray image system. Only the x ray quanta that are absorbed in the screen and emitted as light quanta are useful to produce images. The author describes in detail a special image intensifier, television, and recording system to increase contrast, detail, and resolution, and to reduce dose exposure, for fluoroscopy units. Various considerations of physical factors that affect production of x-ray images are discussed. These include considerations of optimization of the x-ray quantum energy, use of a high quantum gain scintillation raster screen, as well as quanta noise and contrast-detail resolution of the x-ray image. For image intensification with a television system other pertinent factors are discussed. These include study of image signal production by gauging of accumulated charge shapes, and measurement of the noise interval of the image signal. Experimental studies carried out include measurement of the relation between image signal amplitude and image field structure, image propagation, and studies of the image field structure for improvement of the noise interval. A magnetic drum storage is used for recording and retrieval of images from single and multiple image sequences. (BBB)

26173 TISSUE DOSE DUE TO LINEAR RADIUM SOURCES. M. E. J. Young and H. F. Batho (British Columbia Cancer Inst., Vancouver, Can.). J. Can. Assoc. Radiologists, 15: 99-104(Sept. 1964).

Radium dose factors are discussed and a table of tissue correction factors is presented with illustrations on the use of these tables with examples. These Ra dose tables are based on the fact that the fundamental equation for the dose at a point in the vicinity of a linear Ra source can be expressed as the product of two factors. The first of these factors depends on the Ra content M and active length L of the source; the second depends on the relative position of the point in the field but is, apart from a filtration factor, independent of the dimensions of the source. Hence, the dose Ip at point P (x,y) can be expressed as $Ip = (M/L^2) \times F(j,k,\mu d)$ where j and k are coordinates of the point expressed in terms of the active length L as the unit of length (i.e., $j = x/L$ and $k = y/L$); μ is the effective absorption coefficient of Ra γ rays in platinum and d is the effective wall thickness of the platinum container. The values of the dose factor F as given in the tables are based on a specific γ-ray constant for Ra of 8.25 R/mg-hr at 1 cm from a point source filtered by 0.5 mm of platinum. A factor to convert from R to rad in soft tissue is also included in the value of F so that F multiplied by M/L^2 gives directly the absorbed dose in rad/hr. The Ra dose factor tables were calculated on the assumption that all the primary radiation reaching the given point emerged through the lateral wall of the source; the tables are valid only for points for which this condition is satisfied. The tissue correction factors used are based on experimental measurements of Wootton et al. (BBB)

26174 RADIATION PLETHYSMOGRAPH: A NEW BASIS FOR EVALUATING PERIPHERAL CIRCULATION BY THE PRINCIPLE OF PLETHYSMOKYMOGRAPHY. Richard W. Steenburg and Bjorn H. Thomasson (Johns Hopkins Univ., Baltimore). J. Surg. Res., 5: 41-8(Jan. 1965).

A new method for application of the principle of plethysmokymography to the clinical study of various peripheral circulatory disorders is described which utilizes an estimate of the extremity plasma volume rather than the displacement volume of the limb. Plasma volume, estimated by an external counting, radioisotopic technique, is dependent upon the intravascular localization of isotopic tracer, the external count rate being utilized as a direct index of the tracer, and hence of the plasma content of a segment of one extremity. Flow is then calculated from the increase in plasma volume that occurs upon venous occlusion. Observations on the effect of position and exercise on this estimate of plasma volume suggest a further clinical application of this technique in evaluating venous competence. The equipment used include a Tl-activated NaI 3 × 2 in. crystal, pulse-height analyzer, rate meter, and rectilinear chart recorder. A well-type scintillation detector and decade scale are employed to assay plasma samples. Iodine-131 labeled human serum albumin, in a dose of about 1 μC/kg body weight is injected intravenously and adequate time allowed for its intravascular distribution. One lower extremity is then exposed to the scintillation detector, with the remainder of the body shielded by 2 in. of lead, the crystal being located exactly 100 cm from the midpoint of the exposed extremity. The count rate, with the background count subtracted, is utilized as an index of the total quantity of ^{131}I-labeled albumin circulating in the segment of the subject's extremity. A sample of venous plasma is counted in the well-type scintillation counter. A constant, K, was derived which compared the efficiency of the external and the well detectors. It was derived experimentally by a limb phantom consisting of a cylinder 8 cm in dia filled to a depth of 40 cm with 2000 ml of a solution containing ^{131}I. Derivation of this constant permitted calculation of the extremity plasma volume. Moment-to-moment variations in the plasma volume in response to exercise, elevation and venous occlusion could then be measured from a graphic recording of the external count rate. The major disadvantage of this technique is the low count rates (600 to 800 cpm over background) obtained. At this rate, random variations made interpretation of the curves difficult. The solution lies in the development of a more sensitive detector than is currently available, or the use of whole-body and limb counters. (BBB)

26175 CARCINOMA OF BLADDER: COBALT THERAPY. G. B. Goodman and John Balfour (British Columbia Cancer Inst., Vancouver). J. Urol., 92: 30-6(July 1964).

Results and complications are described following radiotherapy in 202 patients with carcinoma of the bladder. Most of these patients were treated with external ^{60}Co beam therapy; 121 received radical ^{60}Co therapy. This group received tumor doses in excess of 5000 rad over three weeks. Others, considered unsuitable for such dosage because of age or poor general condition, received tumor doses of 4500 to 5000 rad (semiradical therapy). Large tumors were treated with larger fields, with correspondingly lower dosage. Single or parallel opposed fields covering the pelvis were used for palliative tumor doses of 2500 to 3000 rad in three weeks. Radiogold seed implant (^{198}Au) was used for selected patients whose disease was of limited extent. Of 15 patients who received this treatment, 11 are alive two yr later. Of 121 patients who received radical ^{60}Co therapy, 86 are known to be alive, although not necessarily free from disease. Of the 49 patients followed for more than 2 yr after treatment, 41 had invasive tumors, and of these 41, there are 21 patients (51%) still alive. Complications encountered during and after radiotherapy are described. The dose in palliative therapy was reduced to avoid reactions due to treatment itself, and no such reactions were encountered. In the semi-radical group four patients did not complete radical treatment because of bowel complications, namely, severe diarrhea, intestinal obstruction, rectal bleeding, and a malignant vesicocolic fistula. Of the other patients, only two had treatment interrupted because of diarrhea but the remainder had no bowel upsets which could be attributed to treatment. Urinary tract complications were infrequent, but one patient who was cystoscoped during his course of therapy had septicemia and another, carcinoma of the renal pelvis, 21 months after treatment. Patients treated by implantation of ^{198}Au, of course, had no bowel complications. Three local recurrences in the bladder, of which two were related to areas of inhomogeneous dosage in the implants, were seen. One patient with a slowly healing local reaction had an average dose of 9000 rad from the implant. Complications encountered following radical ^{60}Co therapy included mild diarrhea in a fourth of the patients but it was readily controlled. Nine patients had spurious diarrhea, with tenesmus and rectal urgency, and treatment was interrupted. One patient developed intestinal obstruction but responded rapidly to conservative management. Late effects occurred in those who had shown immediate reactions to treatment, including 16 cases of bladder contraction, two cases of rectal sigmoid stenosis and of ureteral reflux, and one each of proctitis, rectal ulcer, vesicovaginal fistula, and closed-loop intestinal obstruction. It is concluded that radiotherapy should be the initial treatment for patients with infiltrative carcinoma of the bladder. The survivals presented at two years are better than those for radical cystectomy and useful bladder function is preserved for most survivors. The complications of radiotherapy presented were not considered to be excessive. (BBB)

26176 THE DEVELOPMENT AND SIGNIFICANCE OF THE TREATMENT OF HORMONE SENSITIVE MALIGNANT TUMORS WITH THE AID OF HYPOPHYSEAL REMOVAL. Gottfried W. Dominok (Pathologische-Anatomisches Institut, Medizinische Akademie, Dresden). Mater. Med. Nordmark, 16: 691-4(Nov. 1, 1964). (In German)

Eleven patients with metastasizing tumors that were hormone sensitive were treated by implantation of ^{198}Au within the hypophysis. The radioisotope was contained in a brass capsule plated with Pt of 2.5 mm length and 0.8 mm dia. Essentially all of the β radiation from the source was absorbed in the walls of the capsule. Because the patients, who received various high dosages of irradiation, all died at different times after the implantation, it was possible to study how the results of the irradiations were related to time and amount of dose. The hypophyseal changes consisted of a coagulation necrosis, the magnitude of which

was not always directly proportional to the irradiation dose. The most frequent finding was an extensive unreactivity of the tissue. The finding which usually indicates a necrotic focus, consisting of a hyperemic margin, a wall of leucocytes, and formation of granulation tissue was not observed in any of the cases studied. After irradiation there was no evidence of regeneration in the parenchymal adenohypophysis. In the final stage of necrosis, which only appeared several months after irradiation, the tissue became fibrotic. The results of hypophyseal irradiation were not as favorable as originally expected. However, this procedure may be indicated for inoperable tumors or prevention of metastases. The procedure is not dangerous, and can be carried out in patients in poor physical condition. Even if a cure is not achieved, the survival time is increased as compared to untreated patients. References cited, 59. (BBB)

26177 FUNDAMENTAL STUDIES ON DOSE DISTRIBUTION OF TELECOBALT MOVING THERAPY. Hisashi Ohtake and Toru Yanagisawa (Iwate Medical Coll., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 1067-72(Dec. 1964). (In Japanese)

The dose distribution in a water phantom was studied by changing the rotation angle and the dose distribution in various water phantoms was estimated from results obtained by measuring the dose distribution in air. Measurements of dose distribution were carried out by Colonial's rate meter. Measurements were made at 60°, 120°, and 240° pendulum and 360° total rotation. In general, the most appropriate dose distribution for telecobalt therapy was obtained when the rotation angle was wider than 240°. The dose distribution in various water phantoms could be estimated with considerable accuracy by measuring the dose distribution in air, but this method was so involved that it was very difficult to draw the isodose curve. The dose rate at a given point distant from the rotation center could be estimated by this method easily and accurately. (auth)

26178 ON THE ESTIMATION OF TISSUE DOSE IN THE TREATMENT OF PULMONARY TUMOR. II. CONSIDERATION OF SOME PROBLEMS AND CLINICAL EXPERIENCES. Morimasa Maeda and Takatoshi Kobayashi (Kyoto Prefecture Univ. of Medicine). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 1073-7(Dec. 1964). (In Japanese)

In a previous report, a practical method to calculate the tumor dose in ^{60}Co therapy of a pulmonary tumor from the measured exit dose was described. Additional studies and a critical analysis of previous results are described in this report. (auth)

26179 AN EXPERIMENTAL STUDY ON A COMPENSATING WEDGE FILTER FOR TELECOBALT THERAPY. Hiroshi Tsunemoto and Goro Kusumoto (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 1204-9(Feb. 1965). (In Japanese)

Studies were performed on the compensating wedge filter used in ^{60}Co therapy. As the result, a method was developed for preparing the wedge filter, making use of the contour lines of the patient. The method provides an easy preparation of a wedge filter that is sufficient for clinical purposes. (NSA of Japan)

26180 USE OF ISOTOPES IN HEMATOLOGY. T. Nagai. Nippon Ishikai Zasshi, 51: 725-30(Mar. 1, 1964). (In Japanese)

Applications of compounds labeled with ^{3}H, ^{51}Cr, ^{59}Fe, and ^{60}Co for diagnosis of blood disorders are reviewed. (BBB)

26181 RADIATION TREATMENT OF THE METASTASES TO THE LYMPH NODES OF THE NECK. Hanna Kolodziejska, Janina Kujawska, Jan Skolyszewski, and Wislawa Szymczyk (Inst. of Oncology, Krakow). Nowotwory, 14: 13-18(Jan.-Mar. 1964). (In Polish)

Dosimetry studies using phantoms representing the human neck region were conducted to determine whether the doses used in conventional x ray therapy techniques are adequate to sterilize cancer cells metastatic to cervical lymph nodes without injury to overlying normal tissues. Two single-field and one double-field techniques were evaluated. In all three techniques, 250-kv x rays with a half value layer equivalent to 2.5 mm Cu were used to deliver surface doses of 2700 to 5000 R. Analysis of the phantom measurements indicated that the doses measured in points corresponding to the deep cervical lymph nodes are lower than the doses required to ensure high possibility of cure of squamous cell carcinoma metastatic to these nodes. On the basis of these results it is concluded that the chance of a cure of metastases to the lymph nodes of the neck by radiation therapy is low when conventional x ray therapy is used. (BBB)

26182 INSTRUMENT FOR THE MEASUREMENT OF THE RELATIVE DEPTH DOSE DISTRIBUTION IN RADIATION THERAPY. W. Mauderli and L. T. Fitzgerald (Univ. of Florida, Gainesville). Oncologia, 18: 241-4 (1964). (In German)

An instrument configuration is described for evaluating depth dose distribution in a water phantom. An ionization chamber is moved through the radiation field, which can be adjusted to a max width of 35 cm and 40 cm depth, with an accuracy of ±1 mm. The velocity of the ionization chamber can be regulated by the time constant of an electrometer amplifier. With a velocity of 2 to 4 cm/sec, measurement of a field requires ~5 to 10 min. The output of the ionization chamber is amplified and used as input to an analog to digital converter. The max output is normalized to 100% and the decimal output of the converter is printed out on a modified electric typewriter as a series of digits which form contours, with the intervals between contours established as a percentage of the max radiation intensity. There are 10 intervals of 10% each from 0 to 100%. Each interval is represented by a characteristic digit from 1 to 0. The output of the converter is also recorded on a card punch for later transfer to magnetic tape, for subsequent computer processing to facilitate radiation therapy planning. (BBB)

26183 THE USE OF AN ELECTRONIC COMPUTER IN RADIATION THERAPY. W. Mauderli and L. T. Fitzgerald (Univ. of Florida, Gainesville). Oncologia, 18: 245-9(1964). (In German)

The authors describe a digital computer procedure for determining the isodose curves resulting from single field, pendulum, and rotational radiation therapy. In the program used the relative depth dose data are recorded on magnetic tape for points ½ inch apart in a rectilinear format. For pendulum and rotation therapy the total dose distribution is found by superposition of radiation fields with mutual entry angles of 15°. Since the coordinates do not coincide the dose is linearly interpolated by the program. The program corrects for the deviation of the radiation axis if it is not perpendicular to the skin. These corrections take up most of the computing time. For each point within the patient matrix the program established how much more or less tissue is apparently present because of the oblique radiation approach. For these points the depth dose is appropriately corrected. The addition of two fields, including the corrections and interpolations mentioned, takes about 12 sec. The longest computation time required is 4½ min for a 360° rotation. During this time between 1 and 10×10^6 basic mathematical operations are carried out. The results can be reproduced on a printer in an orthogonal coordinate system or plotted as isodose curves. Plotting requires 4 min. Identification symbols are also plotted. Results of these studies show that the calculated points are within 3% of the measured points, and that the distance between the two is less than 1 cm. The program is written in Fortran II. (BBB)

26184 RAPID BRAIN SCANNING WITH TECHNETIUM-99M. Paul V. Harper, Sean F. Mullan, and Robert A. Fink (Argonne Cancer Hospital, Chicago). Proc. Inst. Med. Chicago, 25: 131-2(Sept. 1964).

Brain scanning was conducted successfully with technetium-99m pertechnetate obtained from a ^{99}Mo generator. Doses in the range of 10 mC were administered to patients, along with carrier iodide (to which it bears a close physical resemblance), with a total-body dose of ~100 mrad. With

optimized collimators having a ¾-in. field of view, count rates of 10,000 to 30,000 per min were observed, permitting bilateral scans in ten minutes, collecting 500,000 counts per scan. The instrumentation involved the use of conventional methods of brain scanning with modifications consisting of four detectors in opposing pairs. Results of ~500 scans made in 150 patients were obtained for tumors of the central nervous system, also for lesions such as infractions, arteriovenous malformations, focal cerebral swelling, and lesions of the skull and scalp. Accuracy in the diagnosis and localization of focal lesions of the central nervous system appeared to be comparable to other methods, and the procedure was more rapid and convenient. No false positive results were obtained, and true positive readings included lesions found in every area of the brain, including the posterior fossa where previous scanning methods proved unsatisfactory. The percentage of accuracy in the localization of brain neoplasms is 90%. (TCO)

26185 DIAGNOSIS OF INTRACRANIAL TUMORS BY RADIOACTIVE MERCURY^{203} AND MERCURY^{197} BRAIN SCANS. Ivan S. Ciric and Paul C. Bucy. Proc. Inst. Med. Chicago, 25: 159(Nov. 1964).

In a series of 90 brain tumors, 68 (75.6%) were accurately localized with either ^{203}Hg or ^{197}Hg. The scan remained negative in 13 cases (14.4%), and equivocal in the other cases. The greatest incidence of localizing scans was found with supratentorial tumors (83%). Incidence of positive scans among the posterior fossa tumors (47.3%) was considerably lower. Glioblastomas (92%) and the meningiomas (94.6%) gave positive and localizing scans in most of the cases. High tumor uptake was also observed with metastatic lesions (72.2%) and sarcomas. Advantages of radiomercury scanning for localization of brain tumors are discussed. (TCO)

26186 PROBLEMS OF FETAL DOSIMETRY DURING OBSTETRIC X-RAY DIAGNOSIS. Giovanni Golfieri and Giuliano Caretti (Universita, Bologna and Istituto Provinciale Ospedaliero di Maternita, Bologna). Radiobiol. Radioterap. Fis. Med., 19: 48-70(Jan.-Feb. 1964). (In Italian)

Fetal dosimetry was studied with the purpose of reducing fetal dose during radiodiagnosis. When beams were screened with 2 mm Al, the beam surface was reduced by more than a half, and the depth was reduced by about one-third. It is suggested that fetal gonads be shielded during radiology. (H.G.D.)

26187 RADIOTHERAPEUTIC TREATMENTS AND LATE RADIOLESIONS. F. Bistolfi (Universita, Genoa). Radiobiol. Radioterap. Fis. Med., 19: 113-32(Mar.-Apr. 1964). (In Italian)

Two cases of late cerebral radionecrosis out of a large bibliographic review made by Lampe are analyzed, building again the dosimetric conditions and comparatively discussing the various values of the biological dose received by the surface cerebral layers (dose/time 600 to 1200 R for an only application and respectively 1500 to 2500 R for an only application). The analysis was carried out to justify the different latency time between irradiation and appearance of the radiolesion (3.5 years respectively 9 months). Such an analysis can be taken as an example of dosimetric reconstruction of a radiotherapic treatment and radiological discussion of the dose factor, useful from the viewpoint of legal medicine. (auth)

26188 ALTERATIONS IN ANTIBIOTIC SENSITIVITY OF INTESTINAL MICROÖRGANISMS ISOLATED FROM THE FECES OF IRRADIATED PATIENTS. G. F. Schiavi and M. Zanetti (Universita, Bologna). Radiobiol. Radioterap. Fis. Med., 19: 443-50(Nov.-Dec. 1964). (In Italian)

Studies were made on 18 patients irradiated for neoplasm of the cervix uteri, in order to ascertain whether alterations in sensibility to antibiotics of choliforms and enterococci isolated from the stools of these patients were eventually present. To such end stools from each patient, before, in the middle, and after the radiological treatment were studied. The results showed an increase in antibiotic resistance more generalized though more moderate for the enterococci, and more elective but also more limited for the choliforms. After having examined the probable causes of the phenomenon, which is author ascribed, although with some reservations, to the histochemical alterations due to radiations on the intestinal walls, the therapeutic repercussions of the results are discussed. The uselessness of indiscriminate antibiotic treatments in radiation diarrhea and consequently the necessity to carry out tests on the sensibility of antibiotics on the more important fecal micro-organisms before the therapy, in order to determine the antibiotic best suited to control the intestinal phenomena is stressed. (P.C.H.)

26189 THE IMPORTANCE OF ANGIOPNEUMOGRAPHIC ALTERATIONS OF THE DIFFERENTIAL DIAGNOSIS BETWEEN POST-IRRADIATION SCLEROSIS AND NEOPLASTIC RECURRENCE. S. Moretti and C. Rimondi (Universita, Bologna). Radiobiol. Radioterap. Fis. Med., 19: 451-81(Nov.-Dec. 1964). (In Italian)

Angiopneumographic researches were made on 12 patients, irradiated 6 months — 2 years before by high energies for pulmonary neoplasm, with pleuropulmonary symptoms of post-irradiatory sclerosis and sometimes suspicion of neoplastic recurrence. The angiopneumographic alterations found and their importance in connection with the subsequent clinical and radiological evolution of the case are discussed. It was concluded that such a research can offer some useful element in the differential diagnosis between post-irradiatory sclerotic alterations and neoplastic recurrence. (P.C.H.)

26190 EXPERIENCES WITH THE SENSITIZATION OF MALIGNANT NEOPLASMS BY ULTRASHORT WAVES. Georg Fuchs (Kaiser-Franz-Josef Spitals, Vienna). Radiobiol. Radiotherap., 4: 247-56(1963). (In German)

A positive relation between increased radiosensitivity of malignant tissue and increased blood circulation has been known for many years. By pretreatment with short-wave irradiation a hyperemia is produced in the tissues exposed, increasing their sensitivity to x irradiation, if it is administered immediately after the pretreatment. It is important to administer the x irradiation when the hyperemia is maximum. The ability to select the location of the electrodes makes it possible to place the tumor in the field of maximum shortwave energy. The field strength is adjusted so that the patient has a sensation of comfortable warmth. Too much heat may produce vasoconstriction. The duration of the shortwave pretreatment ranges from 10 to 15 min. From the results of treatment of several hundred patients over the past 28 yr the skin changes produced are no more than those caused by x irradiation with an equivalent dose. Combined use of short waves and x irradiation does not produce combined injuries of any sort. Short-wave sensitization has been useful in treatment of inoperable mammary carcinomas, parotid tumors, primary bone tumors, and to a lesser extent, intrathoracic tumors. (BBB)

26191 THE RADIOGRAPHER AND MODERN TRENDS IN USE OF ISOTOPES. L. I. Pope (Middlesex Hospital, London). Radiography, 30: 228-35(Sept. 1964).

Some newer radioisotope procedures used for research and diagnosis in a hospital department of nuclear medicine are described, with reference to individual patients. Use of the new Mecasserto whole-body scanning machine is illustrated. It is automatic and moves over the patient, the radiations being converted into light flashes which are picked up on a film. At the end of the scan the bed is moved under a second camera and a photograph of the patient superimposed on to the film of the scan. It is used for body surveys with strip counter giving up to 1 mC ^{131}I; gold surveys after administration of 100 to 200 mC ^{198}Au; and liver surveys after injecting up to 0.5 mC ^{198}Au into a vein. Possible future uses are discussed. Also shown is a set-up for doing renograms with four heads, containing 2-in. crystals of sodium iodide, one for the head, one for each of the kidneys, and one for the bladder. About 15 μC ^{131}I-Hippuran is injected into the patient's vein and is excreted almost at once by the patient's kidneys. The excretion of the kidneys is recorded by four pens. Uses of ^{51}Cr, ^{58}Co, ^{59}Fe, and ^{132}I are also outlined, and use of activation analysis to detect As

ingestion is described. Construction and applications of a whole-body counter are also mentioned, as well as various safety features being applied in a busy hospital radioisotope laboratory. (BBB)

26192 CARCINOMA OF THE CERVIX: RADIATION SALVAGE OF SURGICAL FAILURES. Milton Friedman and Alexander W. Pearlman (New York Univ. and Hospital for Joint Diseases, New York). Radiology, 84: 801-11 (May 1965).

The arrest of postoperative persistent or recurrent carcinoma of the cervix by irradiation is reported. In a series of 38 consecutive cases, 42 per cent of the patients were free of disease for more than five years. Small lesions yield a higher arrest rate. An occasional extensive recurrence can be arrested. Evidence is presented that irradiation can destroy metastatic nodes from carcinoma of the cervix. The radiation technic must be tailored to fit the biologic and geometric requirements for each lesion. The tumor-lethal dose for carcinoma of the cervix varies considerably. It may range from 4,000 Rads in 25 days to 10,000 Rads in 70 days. (P.C.H.)

26193 SKIN REACTIONS AND TISSUE HETEROGENEITY IN ELECTRON BEAM THERAPY. PART I. CLINICAL EXPERIENCE. Norah duV. Tapley and Gilbert H. Fletcher (Univ. of Texas, Houston). Radiology, 84: 812-16 (May 1965).

Skin tolerance tables for electron beam therapy are presented, and the clinical significance of alterations in the electron beam depth dose produced by nonhomogeneous tissues are evaluated. Skin reactions with electron beam treatment were observed to be more pronounced than with ^{137}Cs radiation but were significantly less than those seen with kilovoltage radiation. Neither the energy level of the electron beam of 6 to 18 Mev, the field size, nor the anatomical location of the treatment field significantly influence skin reaction. (P.C.H.)

26194 SKIN REACTIONS AND TISSUE HETEROGENEITY IN ELECTRON BEAM THERAPY. PART II. IN VIVO DOSIMETRY. Max L. M. Boone, E. Howard Crosby, and Robert J. Shalek (Univ. of Texas, Houston). Radiology, 84: 817-22 (May 1965).

An investigation of the effect of tissue heterogeneity on dose distribution in electron beam therapy was carried out in vivo with lithium fluoride. The possible usefulness of a correction factor: 0.65 × cm bone + depth (cm) = effective depth (cm) was explored. The correlation between the water phantom depth dose at the effective depth and the in vivo determination was good. Preliminary calculations suggest that for 18 Mev electrons, 1 cm of pulmonary tissue is the approximate absorption equivalent of 0.5 cm of soft tissue. The technique of in vivo measurements in patients treated with 18 Mev electrons to the tonsillar area is also discussed. (P.C.H.)

26195 TREATMENT OF MALIGNANT NEOPLASMS OF THE GASTROINTESTINAL TRACT WITH A COMBINATION OF 5-FLUOROURACIL AND RADIATION. A RANDOMIZED DOUBLE-BLIND STUDY. Donald S. Childs, Jr., Charles G. Moertel, Margaret A. Holbrook, Richard J. Reitemeier, and Malcolm Y. Colby, Jr. (Mayo Clinic, Rochester, Minn.). Radiology, 84: 843-8 (May 1965).

The clinical results of treatment with radiation alone and with combined radiation and 5-fluorouracil in gastrointestinal cancer were compared. The results showed that in patients who received 5-FU more toxicity developed than in those who received saline. This was especially noted in the more marked degrees of leukopenia and in the occurrence of thrombocytopenia. Radiation treatment administered to the upper part of the abdomen was associated with an increased incidence of nausea, vomiting, and leukopenia; whereas treatment of the lower part of the abdomen and pelvis was associated with an increased incidence of diarrhea. In cases with cancer of the stomach, some superiority of the combined treatment seemed indicated. (P.C.H.)

26196 A RADIUM TECHNIC FOR TREATMENT OF CANCER OF THE CERVIX. John McLean Morris, Chu. H. Chang, and Vera Page (Yale Univ., New Haven). Radiology, 84: 849-58 (May 1965).

The rationale of radium application technics in cancer of the cervix is discussed. A method based on a modified Stockholm system is described, together with the dosimetry involved. Vaginal applicators consisting of a series of rubber cylinders cut to fit the size of tumor and vaginal apex deliver lower doses to the anterior rectal wall than ovoids and provide more flexibility than fixed colpostats. Emphasis is placed on covering the tumor surface and on keeping scintillation probe readings in bladder and rectum within safe limits. Studies showed that the tandem contributes the major portion of the bladder dose, while the vaginal radium plaque contributes most of the rectal dose. Isodose curves based on measurements made in a water phantom are shown for intrauterine and vaginal applicators with standard loadings. Results with this technic have been satisfactory and injury rates low. (auth)

26197 A VAGINAL RADIUM APPLICATOR. Harry W. Burnett, Jr. (New York Hospital-Cornell Medical Center, New York). Radiology, 84: 859-60 (May 1965).

A radium applicator for use in the control of vaginal metastases from carcinoma of the endometrium is described. Its design, dosimetry, usage, and clinical application are discussed and illustrated. The applicator has proved effective in reducing the vaginal recurrence rate to about 3% five years post-treatment. (P.C.H.)

26198 RENAL SCINTIPHOTOGRAPHY WITH THE GAMMA-RAY SCINTILLATION CAMERA AND Hg^{203}–NEOHYDRIN. Alexander Gottschalk and Hal O. Anger Univ. of California, Berkeley). Radiology, 84: 861-7 (May. 1965).

Use of the scintillation camera in renal scanning is described, and the increased clinical scope possible when the shorter exposure times are exploited is demonstrated. With the gamma scintillation camera, renal scintiphotos can be made in as short a time as three minutes with a 100 μC dose of ^{203}Hg-Neohydrin. In children, in whom reduction of renal irradiation is desirable, a 5 μC dose of ^{203}Hg-Neohydrin can be used with a 15 min exposure. This technique gives a renal dose of less than 1 Rad. The tenfold reduction in examination time has important clinical applications. (P.C.H.)

26199 THE BIAXIAL TELECOBALT PENDELUM IRRADIATION OF CERVIX CARCINOMA. DOSE DISTRIBUTION, LOCALIZED DOSE CALCULATION, FOCUSING TECHNIQUES, AND CLINICAL EXPERIENCE. Jans-Joachim Frischbier and Joachim Hasse (Universitat, Hamburg). Strahlentherapie, 126: 481-94 (Apr. 1965). (In German)

Using a Lucite-Water-phantom, the dose distribution for the biaxial pendulum irradiation was measured; four specially suited irradiation conditions were selected for the tumor shapes of cervix carcinoma most commonly found to occur. Dose measurements, done on ten different phantom sizes, showed that the dose distribution does not depend considerably on the body shape of the patients. The focal dose for different points in the small pelvis can be determined easily and exactly by means of percent depth dose values. Results obtained so far justify the use of the irradiation method in the case of progressive cervical carcinoma. (P.C.H.)

26200 REQUIREMENTS OF THE APPARATIVE SETUP OF MEGAVOLT THERAPY INSTALLATIONS OF FREELY PRACTICING RADIOLOGISTS. Felix Wachsmann (Universitat, Erlangen, Ger.). Strahlentherapie, 126: 495-502 (Apr. 1965). (In German)

The advantages of ultrahard rays for treatment of deeply situated tumors are discussed. These include: a greater relative depth dose, skin- and surface protection by the build-up effect, uniform absorption in different tissues, bone protection, and a more simple dose calculation. For a private praxis, only teletherapy units containing radioactive nuclides can be considered as radiation source for ultrahard rays. The problem of isotope and activity selection along with the advantages of fixed or moving field

instruments is discussed. The advantages of radiation sources with or without beam barrier were considered. Finally, from economical consideration it was concluded that radioisotope teletherapy units should be used in private practice. (auth)

26201 IS MEGAVOLT THERAPY READY FOR INSTALLATION BY FREELY PRACTICING RADIOLOGISTS? CLINICAL INDICATIONS AND PRACTICAL EXPERIENCE. Otto Hubacher (Rontgeninstitut Hubacher, Thun, Switzerland). Strahlentherapie, 126: 503-6(Apr. 1965). (In German)

Advantages found in the use of cobalt therapy, especially for the radiologist with a private practice are: increase in the skin tolerance, a decrease in the general reaction in spite of a high single dose, simpler irradiation technique, and better results than those obtained with conventional rays, as proven by the 5-year survival rate. It must be emphasized, that the radiologist with a private practice plays an important role in individual cancer therapy. However, this is possible only in a country, such as Switzerland, in which the tendency for government control is not advanced too far. (auth)

26202 SOME VIEWPOINTS ON THE SELECTION OF SOURCES FOR GAMMA IRRADIATION APPARATUS. Erich Walter (Siemens-Reiniger-Werken AG, Erlangen, Ger.). Strahlentherapie, 126: 507-13(Apr. 1965). (In German)

It is shown that the degree of activity of dose rate of a source may be obtained for a given case. The patient frequency is of great importance. The high expense is not justified by the therapeutic advantages of using strong sources with small diameter and the use of large FSD values. Varying conditions for the private radiologists make it advisable to continue the use of used sources. (auth)

26203 RADIATION PROTECTION AND STRUCTURAL ASSUMPTIONS FOR COBALT IRRADIATION INSTALLATIONS. Fritz Jensen (C.H.F. Mueller GmbH, Hamburg). Strahlentherapie, 126: 519-27(Apr. 1965). (In German)

Requirements for the installation of cobalt-irradiation units in regard to radiation protection, patient observation, and other constructive measures are discussed. They should provide a smooth operation for the daily irradiation schedule. (auth)

26204 ACUTE HEMORRHAGIC PURPURA AFTER X-RAY IRRADIATION. Udo v[on] Pawel-Rammingen (Freie Universitat, Berlin). Strahlentherapie, 126: 528-31(Apr. 1965). (In German)

The appearance of acute hemorrhagic diathesis was observed during palliative radiotherapy of mammaric carcinoma with metastases in 2 lumbal vertabrae. At present the patient has survived 14 months. Similar reports in the literature are pointed out. Radiation influence is discussed as the probable cause. (auth)

26205 ON STUDIES OF THE INFLUENCE OF IONIZING RADIATION ON GROWING VERTEBRA COLUMNS. Vladimir Stasek, Milos Lokajicek, Leopold Palecek, and Jaromir Kolar (Charles Univ., Prague). Strahlentherapie, 126: 532-40(Apr. 1965). (In German)

Children ranging from 2 months to 7½ years were irradiated as a result of malignant tumors in the lumbal and abdominal region. Radiation effects on the vertebral spine and pelvic bones were studied. Using dosimetric analysis, it was concluded that the extent of the induced radiation changes in the vertebral spine of the treated children depends not only on the absorbed dose and the age at the time of irradiation, but also on the interval between irradiation and the observation of those changes. (auth)

26206 PENETRATION OF BRAIN AND BRAIN TUMOR. V. COPPER-64 CHELATES. H. Hacker and A. H. Soloway (Massachusetts General Hospital and Harvard Medical School, Cambridge). Toxicol. Appl. Pharmacol., 6: 731-7 (Nov. 1964).

A study was made of the tissue distribution of ^{64}Cu through the mediation of 13 chelates. The results are compared with ionic copper and copper bound to ethylenediaminetetraacetic acid. From these data, 4 compounds, alanine, cysteine, isonicotinic acid hydrazide, and diethylenetriaminepentaacetic acid, have emerged as promising agents for use with ^{64}Cu in the localization of brain tumors by a scanning procedure. The effect of these ligands, on the movement of metals, is also discussed. (auth)

26207 RADIOISOTOPE HYPOPHYSECTOMY IN THE THERAPY OF ADVANCED CANCER OF THE BREAST. Pietro Bucalossi, Gianluigi Buraggi, Vinicio C. Catania, and Enrico Miserocchi (Istituto Nazionale per lo Studio e la Cura dei Tumori, Milan). Tumori, 50: 499-517(Nov.-Dec. 1964). (In Italian)

The necessary doses and the subsequent effects in the use of ^{198}Au and ^{90}Y implants to destroy the pituitary are discussed. These isotopes were implanted, by means of cylinders containing doses of 1 to 10 mC, in the pituitaries of 102 women. In each patient the glandular volume submitted to a dose able to produce necrosis was calculated. Hypophysectomy was considered to be total when the whole gland had received a dose of 100,000 rad. The validity of this method was checked in six patients where the destroyed hypophyseal volume could be measured by histological methods. Measured and calculated values were found to agree. Improvement of symptomatology and general condition was obtained in the 51%, and in some patients (20%) objective regressions of the neoplastic changes were observed. Best results were obtained in fertile patients, with a total improvement value of the 54%, especially among those patients treated by oophorectomy and ovarioadrenalectomy, followed by hypophysectomy (61% showing improvements). The best results were obtained in cases with a single type of radioisotope localization. Results were more favorable in patients with adenocarcinoma (54%) than in patients with solid carcinoma (45%). A comparison of the survival curves of patients treated by hypophysectomy, by ovarioadrenalectomy, and by medical or radiological palliation showed increase of the survival rates in patients treated by endocrine surgery. Complications consisted of traumatic lesions in cranial nerves, meningitis which caused the death of the patients; and lasting diabetes insipidus. It is concluded that radiohypophysectomy, in over half the cases considered, provided palliative treatment. (TCO)

26208 RADIATION BIOLOGY AND CANCER. L. H. Gray (Mount Vernon Hospital, Northwood, Middx., Eng.). p.7-25 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Factors affecting the success of tumor radiotherapy that are reviewed include: the number of reproductive cells actually present in the tumor; and anoxia. Mechanisms of radioinduced carcinogenesis are discussed. Papilloma incidence was investigated in animals treated with croton oil prior to irradiation with 1.8 Mev electrons. At doses under 800 rad, no papillomas attributable to irradiation were obtained. However, a small but statistically insignificant number of these tumors were produced by 800-rad doses. (H.M.G.)

26209 PROGRESS REPORT ON PITUITARY IRRADIATION. C. A. Tobias (Univ. of California, Berkeley), J. H. Lawrence, J. Lyman, J. L. Born, A. Gottschalk, J. Linfoot, and J. McDonald. p.19-35 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Reasonably safe techniques for achieving partial or nearly complete radiation hypophysectomy in the human being are discussed. These include pituitary transirradiation and Bragg-peak methods. Therapeutic investigations have shown that several diseases are profoundly modified by pituitary radiation. The studies stimulate research into fundamental understanding of the role of the hypophysis. (P.C.H.)

26210 INTRACRANIAL LESIONS MADE BY THE BRAGG PEAK OF A PROTON BEAM. R. N. Kjellberg (Massachusetts General Hospital and Harvard Univ., Bos-

ton, and Harvard Univ., Cambridge, Mass.), A. M. Koehler, W. M. Preston, and W. H. Sweet. p.36-53 of "Response of the Nervous System to Ionizing Radiation." Boston, Little, Brown and Co., 1964.

Developments in the Bragg peak of the proton beam for intracranial ablation are described. The technique involves the use of a stereotaxic head holder so mounted as to rotate around both vertical and horizontal axes, thus enabling the placement of both the intersection of these axes and the intracranial target at the Bragg peak. Experiments with the use of cebus monkeys are described. With the use of a single portal 7.1 mm in diameter and placement of the Bragg peak within the brain, the histological effects within and around the entire longitudinal path of the radiation beam were examined. Usually 1 mm encompasses the entire transition zone from central coagulation necrosis to the normal appearances surrounding the lesion. The ability to place the Bragg peak exactly where desired was also demonstrated. The general effects beyond the target area of focal, high doses, given at the rate of 200 to 7000 rad per minute were also considered. The clearest-cut effect was that death occurred within 1 to 11 days in monkeys irradiated to a total of 20,000 Rad confined to a single beam 7.1 mm in diameter, whereas those given only 10,000 Rad survived over 1 year. The highest dose rates seemed to be more lethal than the lowest. Hemorrhagic pulmonary edema in 8 animals, pneumonitis in 4, and hepatitis in 3 were major factors contributing to the deaths of 15 of the monkeys. The effects of two types of localization of a sequence of sublethal doses of radiation was appraised. In one group of 7 monkeys, a series of 7 or 8 exposures, each at 10,000 Rad, was given to the same locus during a period of 100 to 200 days. All of these animals survived. But when the same number of exposures at 10,000 Rad, over a similar period, was given each time to a different locus, all 7 monkeys died. As a result of the animal experiments, irradiation of the relatively normal pituitary gland was done in patients with advanced hemorrhagic diabetic retinopathy or with carcinoma of the breast with metastases. Details of the technique with the 7 mm portal and dosimetry to the important neighboring oculomotor and optic pathways are given. Patients with pituitary tumors were treated with larger portals. A destructive lesion with a 7.1 mm portal centering on the ventrolateral nucleus of the thalamus has been made in 2 patients with Parkinson's disease. In general it was concluded that the Bragg peak of the proton beam lends itself to certain intracranial ablations, and unequivocally demonstrated that these can be done with relatively modest inconvenience to patients, and even in those whose disorders have reached a magnitude precluding conventional surgical techniques. (P.C.H.)

26211 PROGRESS IN ATOMIC MEDICINE. VOLUME I. John H. Lawrence, ed. New York, Grune and Stratton, 1965. 238p.

Eight chapters with one addendum are included; separate abstracts were prepared for each. (P.C.H.)

For abstracts of individual chapters see: 25891, 26212, 26213, 26214, 26215, 26216, 26217, 26218, and 26277.

26212 THE WHOLE-BODY COUNTER IN MEDICAL RESEARCH AND DIAGNOSIS. Stanton H. Cohn. p.1-33 of "Progress in Atomic Medicine. Vol. I." New York, Grune and Stratton, 1965. (BNL-7602).

A review is presented on developments in whole-body counting systems designed for medical research and their applications. The detector, electronics, shielding, and patient-detector geometry are discussed in detail. The advantages of whole-body counting are also cited. 103 references are included. (P.C.H.)

26213 PROGRESS IN RADIOISOTOPE SCANNING: CLINICAL APPLICATION OF THE SCINTILLATION CAMERA. Alexander Gottschalk and Hal O. Anger (Univ. of California, Berkeley). p.78-106 of "Progress in Atomic Medicine. Vol. I." New York, Grune and Stratton, 1965.

The scintillation camera is described, and clinical results obtained with it are discussed. Developments in equipment and technique and advantages of the scintillation camera are given. (P.C.H.)

26214 SHORT-LIVED ISOTOPES AND POSITRON EMITTERS IN MEDICINE. Michel M. Ter-Pogossian (Washington Univ., St. Louis). p.107-26 of "Progress in Atomic Medicine. Vol. I." New York, Grune and Stratton, 1965.

Features and limitations of the use of short-lived isotopes in medicine, generation of short-lived radioactive isotopes, properties of some short-lived isotopes useful in medicine, and positron emitters in medicine are discussed. (P.C.H.)

26215 HEAVY PARTICLES IN MEDICINE. John H. Lawrence and Cornelius A. Tobias (Univ. of California, Berkeley). p.127-46 of "Progress in Atomic Medicine. Vol. I." New York, Grune and Stratton, 1965.

The use of high-energy heavy-particle beams in therapy with or without the Bragg peak to deliver large amounts of energy to relatively localized areas of the body including the pituitary gland, brain, and soft tissues in the successful treatment of several metabolic, neoplastic, and neurologic diseases including acromegaly, Cushing's disease, diabetic retinopathy, and brain and soft-tissue tumors is discussed. The properties of the heavy particles, including their linear energy transfer, RBE, independence of oxygen concentration, and lack of tissue recovery are described. Particles such as pi mesons are also being studied to find how they might be used advantageously in radiotherapy. (P.C.H.)

26216 THE PRESENT STATUS OF THERAPY WITH RADIOACTIVE COBALT AND OTHER HIGH-ENERGY X-RAY AND GAMMA-RAY SOURCES. Vincent P. Collins (Baylor Univ., Houston, Tex.). p.147-73 of "Progress in Atomic Medicine. Vol. I." New York, Grune and Stratton, 1965.

The history, development, and present status of radiotherapy with ^{60}Co and other high energy x-ray and gamma sources are discussed. This includes the skin-sparing effect, depth dose, uniform absorption in tissue, beam definition, RBE, and economics of high-energy radiation. The use of high-energy radiation for clinical radiotherapy of head and neck cancer, lung cancer, carcinoma of the breast, carcinoma of the cervix, and carcinoma of the bladder is described. (P.C.H.)

26217 RADIOACTIVE ISOTOPES OF IODINE IN THE DIAGNOSIS AND TREATMENT OF DISEASES OF THE THYROID GLAND. M. N. Fateeva (Inst. of Medical Radiology, Moscow). p.174-218 of "Progress in Atomic Medicine. Vol. I." New York, Grune and Stratton, 1965.

The use of ^{131}I and also ^{132}I, ^{125}I, and ^{123}I in the diagnosis and treatment of thyroid diseases is reviewed. ^{131}I metabolism, investigation of thyroid physiology using ^{131}I, organically bound ^{131}I, diagnostic tests of thyroid function, interpretation of radioisotope thyroid function tests, extrathyroidal measurements of thyroid function, ^{131}I scanning as a test of thyroid function, use of ^{131}I in thyroid function studies in children, other isotopes of iodine, results of ^{131}I therapy, and alternative approaches to therapy with ^{131}I are discussed. 135 references are included. (P.C.H.)

26218 IODINE 131 IN THE TREATMENT OF THYROID CANCER AND ITS USE FOR THYROID ABLATION IN CERTAIN NONTHYROID DISEASES. Norton J. Snyder (Univ. of California, Berkeley). p.219-26 of "Progress in Atomic Medicine. Vol. I." New York, Grune and Stratton, 1965.

The use of ^{131}I in the treatment of thyroid cancer and for thyroid ablation in nonthyroid diseases is reviewed. This includes clinical evaluation, selection of surgical procedure, ^{131}I therapy in children, selection of patients, response to therapy, and complications of therapy. (P.C.H.)

CHEMISTRY

General

Refer also to abstracts 26917, 27735, and 27767.

26219 (ORNL-TM-1069) CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, OCTOBER 1964. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 27p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Work was continued to develop an in-line optical instrument to measure aerosol particle size and concentration. The best results have been obtained with a He–Ne gas laser as the primary light source. Latex particles in air as small as 0.3 μ dia were detected with a signal to noise ratio of 3:1. As a part of the engineering development of the Sol-Gel process, preliminary testing of a vertical tube furnace for calcination and reduction of gel to produce ThO_2–UO_2 was made. Waste processing test R-86, -87 was a rising level glass test in an 8-in.-dia vessel heated by an induction furnace through a 15-in.-dia susceptor. The average feed rate was 8.8 liters/hr and the glass product had a density of 2.13 g/cc. The test was interrupted by a short between two zones of the induction furnace. Temperature control was difficult because of cross-coupling between adjacent zones of the furnace. (auth)

26220 (RFP-516A) UNCLASSIFIED PUBLICATIONS THROUGH 1964. (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). Mar. 29, 1965. Contract AT(29-1)-1106. 38p. Dep.; $0.50(cy), 1(mn) CFSTI.

The references are arranged under the following headings: patents, drawings, reports, journal publications, and speeches. An author index is included. (D.L.C.)

26221 (TID-21327) PROGRAM OF OFFSITE RESEARCH IN CHEMISTRY. An Ad Hoc Panel Report. (Division of Research (AEC), Washington, D. C.). Nov. 19, 1964. 21p. Dep.; Free(DTIExtension)

The Ad Hoc Panel conducted a scientific review and an evaluation of the off-site research supported by the AEC Chemistry Programs. Program content, quality, fund distribution, and administration are discussed. Recommendations are given for the future guidance of the Chemistry Programs. (D.L.C.)

Analytical Procedures

Refer also to abstracts 26529 and 26539.

26222 (AD-607585) DEVELOPMENT OF ANALYTICAL TECHNIQUES FOR THE DETERMINATION OF MINUTE QUANTITIES OF SELECTED ELEMENTS IN BERYLLIUM. Interim Report No. 3, May 20–July 20, 1964. W. M. Henry (Battelle Memorial Inst., Columbus, Ohio). Oct. 7, 1964. Contract NOw-64-0081-c. 22p. $1.00 (CFSTI).

The efforts discussed were principally in the areas of (1) obtaining additional high-purity beryllium materials, (2) development of a sensitive emission spectrographic technique, (3) additional effort in mass spectrography on evaluating plates and in the assembly of an electron-beam sample-cleaning gun, (4) the investigation of a vacuum-fusion extraction method to determine carbon in beryllium and (5) the preparation of enriched-oxygen-in-beryllium standards. (auth)

26223 (AECL-2137) THE DETERMINATION OF CHLORINE IN POLYPHENYL REACTOR COOLANTS AND RELATED ORGANIC COMPOUNDS. R. B. Stewart, R. W. Jones, S. Elchuk, and G. G. Smith (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan. 1965. 31p. Dep.; $1.00(AECL).

A rapid method for the determination of chlorine in polyphenyls, and organic solutions is described. It consists of a decomposition of the organic matrix by combustion in an oxy-hydrogen flame, condensation of the water vapor and hydrochloric acid produced, and determination of the chloride by precision null-point automatic titrimetry. A sensitivity of 0.5 ppm chlorine is available in low- and medium-viscosity samples, 1 ppm in high-viscosity coolants. (auth)

26224 (AERE-R-4872) THE DETERMINATION OF ZIRCONIUM-95 IN GRAPHITE FROM H.T.G.C. LOOPS. AN ANION EXCHANGE SEPARATION OF ZIRCONIUM-95 FROM SCANDIUM-46 AND IRON-59. J. W. Arden and J. W. McMillan (Atomic Energy Research Establishment, Harwell (England)). Mar. 1965. 10p. Dep.; $0.30(BIS); 1s. 9d. (HMSO).

Barium fluozirconate and di-(2-ethylhexyl) phosphoric acid extraction methods for zirconium-95 determination in graphite from High Temperature Gas Cooled Loops were found to be unsatisfactory because of interference from scandium-46 and iron-59. A suitable procedure was devised by combining the barium fluozirconate procedure with an anion exchange separation of zirconium-95 from scandium-46 and iron-59. (P.C.H.)

26225 (AERE-R-4881) THE DETERMINATION OF SELENIUM IN HAIR BY NEUTRON-ACTIVATION ANALYSIS. D. Betteridge (Atomic Energy Research Establishment, Harwell (England)). Mar. 1965. 15p. Dep.; $0.50 (BIS); 2s. 6d. (HMSO)

Selenium in hair is determined by neutron-activation analysis by using the $^{80}Se(n,\gamma)^{81,81m}Se$ reaction. After irradiation, the hair is decomposed in the presence of selenium carrier containing selenium-75, and the selenium separated as the complex with 3,3′-diaminobenzidine. The chemical yield is determined by counting the selenium-75 when the activity of relatively short-lived selenium-81 and -81m is negligible. Several samples of hair have been analyzed for selenium and the significance of the results is discussed. (auth)

26226 (CEA-R-2721) ESSAI D'ANALYSE ABSOLUE PAR SPECTROMETRIE DE MASSE A ETINCELLES. (Test of Absolute Analysis by Spark Source Mass Spectrometry). Michel Desjardins (Commissariat à l'Énergie Atomique, Grenoble (France). Centre d'Études Nucléaires). 1965. 45p. Dep.(mn).

Thesis submitted to Grenoble Univ. (France).

A graphical method was used to study the linearity of response of the MS 7 mass spectrometer for impurity determinations over a concentration range of 1 to 1,000 ppm. This method consists in transforming optical density measurements into "true intensities," which are plotted on a log paper against the exposures. A moving transparent ruler graduated at the inverse scale of the exposures allows one to determine directly on the graph, the concentration of impurities in ppm. This method was used for the determination of sensitivity coefficients in standard samples such as Al, Fe, Cu, Ni, Zr, and nonconducting powders like SiO_2 and Al_2O_3. This study shows that, for the samples studied, the sensitivity coefficients are practically independent of the matrix and the concentration. Moreover, the results show the possibility of obtaining an absolute analysis by spark source mass spectrometry. (auth)

26227 (CEA-R-2766) DOSAGE POTENTIOMETRIQUE DE L'ACIDITE NITRIQUE LIBRE DANS LES SOLUTIONS ORGANIQUES DE TRILAURYLAMINE. (Potentiometric Determination of Free Nitric Acid in Trilaurylamine Solutions Containing Plutonium Nitrate). Jean-Jacques Perez and Jean-Claude Saey (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre de Études Nucléaires). Mar. 1965. 44p. Dep.(mn)

A potentiometric method of determination of the free

nitric acid in trilaurylamine solutions containing plutonium or thorium nitrates is described. The potentiometric titration is carried out in a mixture of benzene and 1,2-dichloroethane with a standard solution of trilaurylamine as the titrant. When thorium nitrate is present, the metal complex is not dissociated, and then the titration has a single end-point. In the case of plutonium nitrate, the partial dissociation of the plutonium complex corresponds to a second point. The experimental error in duplicate analyses of 50 samples is about 1 per cent for free acid concentrations in the range of 0.03 to 0.1 N and plutonium concentrations between 1 to 5 g/l. (auth)

26228 (GAT-501) THE MICRODETERMINATION OF SULFUR IN URANIUM COMPOUNDS. C. R. Walker and C. F. Trivisonno (Goodyear Atomic Corp., Piketon, Ohio). Mar. 15, 1965. Contract AT(33-2)-1. 10p. Dep.; $1.00 (cy), 1(mn) CFSTI.

A method was developed for determining microgram quantities of sulfur in uranium compounds. In the method, which is also suitable for analyzing a wide variety of other materials, the sulfur is reduced and distilled as hydrogen sulfide from a mixture of hydrochloric, hydriodic, hypophosphorous, and phosphoric acids. The distilled hydrogen sulfide is treated with cupric ion in an acetate medium at pH 4.8 to 6.0 to produce the brown color of cupric sulfide. The color is sufficiently stable for a colorimetric determination of sulfur at a wavelength of 350 millimicrons. Nitrate, which interferes with the determination, is easily removed prior to the analysis. This method detects a minimum of 1 to 2 micrograms of sulfur while the limit of error in the 1–50 microgram range is 8 percent at the 95 percent confidence interval. (auth)

26229 (INR-590/VIII) METODY OPREDELENIYA SLEDOVYKH KOLICHESTV ZHELEZA, ALYUMINIYA I OKISI KREMNIYA V VODE PERVOGO KONTURA YADERNYKH REAKTOROV. (Methods for Determination of Trace Amounts of Iron, Aluminum and Silicic Acid in the Reactor Water of the Primary Circuit). T. Novitska-Yankovska and A. Golkovska (Institute of Nuclear Research, Warsaw (Poland)). [1964]. 18p. CFSTI.

The problem of determination of silica in water is discussed. The results of the determination of silica in the reactor water are shown. Silicon was determined by the molybdenum blue method. The water samples were prepared by various procedures. Statistic calculations were performed for the comparison of the used procedures. Two methods of the determination of iron are discussed. Iron was determined as complex with 2,2'-dipyridyl or with 4,7-diphenyl-1, 10-phenanthroline. The results obtained by these methods are shown. Hematoxylin was used as reagent for aluminum. The results of the determination of aluminum in the reactor coolant water are shown. (auth)

26230 (LA-3247) THE SPECTROPHOTOMETRIC DETERMINATION OF SILICON IN PLUTONIUM. T. K. Marshall, K. S. Bergstresser, and G. R. Waterbury (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Jan. 31, 1965. Contract W-7405-eng-36. 14p. Dep.; $1.00(cy), 1(mn) CFSTI.

Microgram quantities of silicon are separated from plutonium by selectively precipitating plutonium(III) and (IV) fluorides, and the silicon in the supernatant solution is determined spectrophotometrically as the reduced silicomolybdic acid complex. Boric acid is used to complex and prevent interference caused by the excess fluoride ion during the formation of the blue silicomolybdic acid complex. The absorbance of the complex is measured at a wavelength of 825 mμ. Based upon 14 determinations each of 52, 104, and 152 ppm of silicon in plutonium (10.4, 20.8, or 31.4 μg of silicon added to 200 mg of plutonium), the relative standard deviation of the method was found to be 3.7, 1.8, and 2.8%, respectively. The molar absorptivity of 16,600 calculated from these data shows that 10 ppm (2 μg of silicon in a 200-mg plutonium sample) can be determined reliably. High concentrations of chromium, germanium, iron, nickel, or potassium interfere in this determination. (auth)

26231 (NLCO-944) ABSORPTION CORRECTION TABLES FOR MICROPROBE ANALYSIS— EFFECT OF CRITICAL EXCITATION POTENTIAL. J. W. Colby (National Lead Co. of Ohio, Cincinnati). May 7, 1965. Contract AT(30-1)-1156. 14p. Dep.; $1.00(cy), 1(mn) CFSTI.

New tables have been prepared which, when used with earlier tables (in NLCO-914), permit the effect of overvoltage to be easily taken into account. They may be used with any commercially available microprobe having a fixed x-ray emergence angle and any accelerating voltage up to 40 kv. (auth)

26232 (ORINS-49(p.135-5)) METHODOLOGY. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.).

A procedure is described for the collection and processing of feces for quantitative analysis that uses sealed plastic disposable containers from which samples are removed with a needle and syringe. The procedure can be used conveniently to prepare samples for chemical, radioisotopic, and other quantitative procedures. An automatic zonal scraper and sample collector is described for use in the radioassay of thin-layer chromatograms. (C.H.)

26233 (PG-Report-628) ANALYTICAL METHOD FOR THE FLAME-PHOTOMETRIC DETERMINATION OF SODIUM AND POTASSIUM IN ALUMINA. (Production Group, United Kingdom Atomic Energy Authority, Springfields (England)). 1965. 8p. Dep.

The sample is dissolved in phosphoric acid and the solution analyzed for sodium and potassium using an EEL flame photometer. The method is suitable for the determination of 0.1–2.0% sodium and 0.2–2.0% potassium in alumina which can be in the form of either powder or sintered pellets. The maximum error is estimated as ±15% (relative) at the 0.5% sodium or potassium level. (auth)

26234 (RISÖ-97) ON THE THEORY OF THE NEUTRONIC METHOD FOR MEASURING THE WATER CONTENT IN SOIL. P. L. Oelgaard (Atomenergikommissionen, Risø (Denmark). Forsoegsinstitut). Jan. 1965. 45p. Dep.(mn).

Investigations on the theoretical treatment of the neutronic method for measuring the water content in subsurface soil are reported. By comparison with experimental data for the thermal flux distribution around a fast neutron point source in pure water a three-group diffusion-theory model was selected as the basis of the investigations. The geometry considered for the soil moisture probe is a fast neutron point source in an infinite, homogeneous medium and a line detector with its center at the source. The formulas used are derived, the methods applied for determining the necessary nuclear constants of the soil are described, and tables of cross sections are given. Up to 20 elements are involved in the determination of the nuclear constants. Numerical calculations for typical Danish soil types for which experimental investigations have been performed and chemical analyses are available, were carried out by means of an ALGOL computer program. The results were compared with experimental results, and excellent agreement was found. The effect of variation of a number of parameters was studied. Changes of the density, the absorption cross section, and the content of hydrogen in the dry soil were found to be important for the count-rate obtained. Objections are raised to the concept of the sphere of influence, and instead a new concept, the sphere of importance, which is consistent with theory and experimental data, is introduced. A print-out of the ALGOL program is appended. (auth)

26235 (CEA-tr-A-1801) SEPARATION PAR CHROMATOGRAPHIE SUR PAPIER DE QUELQUES PRODUITS DE FISSION DE L'URANIUM. (Separation by Paper Chromatography of Some Fission Products of Uranium). N. Getoff. Translated into French from Oesterr. Chemiker-Ztg., 62: 334-5(1961). 6p. Dep.(mn); $1.10(fs), $0.80(mf), JCL.

The effects of citric acid on the paper chromatographic separation of some fission products were studied. Some solvent mixtures useful for the separation of $^{137}Cs-^{90}Sr-^{90}Y$, $^{137}Cs-^{140}Ba-^{140}La$, and $^{137}Cs-^{144}Ce$ are given. (tr-auth)

26236 APPLICATION OF THE METHOD OF LIQUID SCINTILLATION TO ASSAYS OF TRITIUM IN ESTIMATING TOTAL WATER IN RATS. Stanislaw Chwalinski, Andrzej Mikulski, and Maria Kossakowska. Acta Physiol. Polon., 16: 141-9(1965). (In Polish)

A technique of assaying tritium in biologic materials by the method of liquid scintillation was developed. Tritium water was used for estimating total water in rats. Experiments were carried out with 122 rats of the Wistar race, of both sexes and different body weight. It was found that total water, determined with this method, fluctuates between 68.3 and 71.9%, with a mean of 69.8%. These values are in agreement with the commonly accepted values of water content in rats. (auth)

26237 ON THE REACTABILITY OF SOME MERCAPTODIPHENOLS. III. SOLVATION OF THE HYDROXIDE AND SULFIDES OF HEAVY CATIONS BY MERCAPTOHYDROQUINONE AND 4-MERCAPTORESORCINOL. F. Buscarons and J. Alsina (Universidad, Barcelona). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 40: 695-700 (Nov. 1964). (In Spanish)

The metal complexing ability of some aromatic mercaptans with hydroxy groups in vicinal position to the mercapto group was studied. Mercaptohydroquinone and 4-mercaptoresorcine were studied as masking agents in the precipitation reactions of metallic hydroxides and of metallic sulfides. These mercaptans form soluble complexes with many cations, as: Bi, Sb, Fe(II), Fe(III), Zn, Mn, Ni, Co, U(VI), Ti, Th, In, and Tl(III), being so stable they prevent the precipitation of these ions as hydroxide or sulfide. The complexing ability of these mercaptodiphenols was also compared with that of some aliphatic mercaptoalcohols. (auth)

26238 METHOD OF EXTRACTION WITH SOLVENTS APPLICABLE TO THE CHEMICAL ANALYSIS OF URANIUM. I. STUDIES OF THE EXTRACTION WITH TRIBUTYL PHOSPHATE-METHYL ISOBUTYL KETONE. J. Vera Palomino, F. Palomares Delgado, and J. C. Petrement Eguiluz (Junta de Energia Nuclear, [Madrid]). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 40: 701-14 (Nov. 1964). (In Spanish)

A factorial study of the selective extraction of uranium with a mixture of TBP 4-methyl-2-pentanone was carried out using 0.8N nitric acid and different salting agents. The most suitable salting agent was used to develop new factorial experiments in order to get an equation involving the percent of extracted uranium, E, the concentration of the extractant agent in the organic phase, c, and the concentration of the salting agent in the aqueous phase, n. From the equation $\log E = 2 - 0.6^{(C/2)^{-1}}(2.33/2.46^{n} - 0.04)$, the isoextraction curves were obtained in the c, n plane, where the best working conditions were chosen. The effects of the acid concentration on the extraction were also studied. (auth)

26239 THE DETERMINATION OF CARBON IN SODIUM. J. A. J. Walker and E. D. France (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). Analyst, 90: 228-33(Apr. 1965).

A method was developed for determining free carbon in sodium at the parts per million level. Sodium is removed by distillation at 600°C for 8 hr and the carbon in the residue determined by combustion in an excess of oxygen at 1200°C. The carbon dioxide formed was measured manometrically. Additions of carbon to sodium for the levels 3, 6, and 12 ppm were recovered satisfactorily with a standard deviation of 0.5 ppm of carbon. The possibility of loss of carbon because of interaction with sodium oxide was investigated. (auth)

26240 AUTOMATIC EVALUATION OF TWO-DIMENSIONAL RADIOCHROMATOGRAMS. J. Sevcik and J. Zelinka. Biologia, 29: 864-8(1964). (In Czech.)

The principle and the step-wise development of the evaluation of radiochromatograms are discussed, and an apparatus for the automatic evaluation of two-dimensional radiochromatograms, radioelectrochromatograms, and radioelectrophoreograms is described. Practical experiments produce the proof that the preparation and evaluation of radioelectrochromatograms is the most advantageous. In the experimental re-examination of the accuracy of the device it was established that in an evaluation, repeated 1035 times, of the radioactive spots only 164 exposures showed an error greater than ±2% and no exposure deviated more than 5% from the mean value. (tr-auth)

26241 GAMMA-RAY SPECTROMETRY IN RADIOACTIVATION ANALYSIS WITH 14-Mev NEUTRONS. Yuzura Kusaka, Haruo Tsuji, Isao Fujii, Haruo Muto, and Katsuhiko Miyoshi (Konan Univ., Kobe, Japan and Shibaura Electric Co., Ltd., Tokyo). Bull. Chem. Soc. Japan, 38: 616-24(Apr. 1965).

The analytical sensitivities of various elements for gamma spectrometry following neutron activation were determined. The gamma spectra of 37 elements are shown and the experimental method described. The elements data are given for Pr, Ba, Cu, Ce, Br, Se, F, Rb, Si, Sb, Ge, Ga, Ag, V, Y, Au, P, Hf, Cd, Zr, Al, N, Na, Hg, As, O, Cr, Mo, Zn, Sr, Sm, Mn, Mg, K, Fe, Co, and Ni. (M.C.G.)

26242 THE DETERMINATION OF POTASSIUM IN SODIUM SALTS BY ATOMIC ABSORPTION METHOD. Masao Takahashi and Yaeko Takashima (Japan Atomic Energy Research Inst., Tokyo). Bunko Kenkyu, 13: 14-18(Nov. 1964). (In Japanese)

The determination of potassium in sodium salts is made with the atomic absorption spectrophotometer described in a previous paper. This served as a performance test of the spectrophotometer. By the atomic absorption method, potassium in sodium salts is quantitatively determined down to 5 ppM without chemical separation. In comparison with the flame photometric method, the atomic absorption method is equally accurate and sensitive, and it is rapid and free from interference by extraneous elements. (auth)

26243 A METHOD OF EMISSION-SPECTROGRAPHIC DETERMINATION OF STRONTIUM FOR SOIL ANALYSIS. Kiyashi Kodaira and Keiko Kitayama (National Inst. of Agricultural Sciences, Japan). Bunko Kenkyu, 13: 18-23 (Nov. 1964). (In Japanese)

To determine about 1 μg of Sr in soil, a method of emission spectrography based upon a powder method with a Cr internal standard was developed. The addition of silica and potassium phosphate makes the intensity of Sr and Cr lines tend to decrease in the earlier period of arcing but increase in the later period. Small amounts of these chemicals are added in consideration of the composition of soil. From the calibration curve and the effect of Ca addition, this method is presumed to be applicable to the determination of 0.5 to 10 μg of Sr in 150 mg of powder (3.3 ~ 67 ppM) in the presence of 500 μg (0.3%) of Ca. This analytical condition is considered favorable for the determination of Sr in soil. (auth)

26244 DETERMINATION OF HYDROGEN IN URANIUM METAL BY THE ISOTOPIC BALANCING-SPECTROSCOPIC METHOD. Hiroshi Kawaguchi (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 14: 138-44(Feb. 1965). (In Japanese)

An isotopic balancing-spectroscopic method developed by Zaidel is applied to the determination of hydrogen in uranium metal. Uranium metal is heated in a quartz exchanger vessel with deuterium gas for the isotopic balancing. Heating at 1000°C for 30 minutes is necessary for the attainment of equilibrium. For the spectroscopic analysis of hydrogen-deuterium mixtures, a 27-megacycle electrodeless discharge is used as the light source. The Fabry-Perot interferometer with a narrow-band interference filter is employed for recording the spectrum H_β and D_β. The relative error is 3 to 7% for hydrogen contents between 5 and 0.5 ppM in a sample of 17 g. The time required for an analysis is 50 to 60 minutes. (auth)

26245 DETERMINATION OF OXYGEN IN METALS BY ISOTOPE DILUTION METHOD. Keiichi Furuya, Iichi Ogahara, and Hitoshi Kamada (Tokyo Univ.). Bunseki Kagaku, 14: 330-5(Apr. 1965). (In Japanese)

An isotope dilution apparatus was constructed for the determination of gases in metals using ^{18}O-labeled carbon monoxide in order to calibrate the gas adsorption effect in vacuum fusion analysis. Oxygen in nitriding steel and Zircalloy samples was determined under identical conditions by vacuum fusion and isotope dilution methods. About 15 ppm difference because of gas adsorption was found in nitriding steel between the results by the two methods, but the gas adsorption could not be found by using tin bath technique in the vacuum fusion method. Analysis of Zircalloy using the platinum bath gave no detectable error from gas adsorption. (auth)

26246 DETERMINATION OF NITROGEN IN STEELS BY ISOTOPE DILUTION METHOD. Keiichi Furuya and Hitoshi Kamada (Tokyo Univ.). Bunseki Kagaku, 14: 336-8 (Apr. 1965). (In Japanese)

An isotope dilution method using ^{15}N-labeled nitrogen was applied to the determination of nitrogen in National Bureau of Standards standard steel sample 1044 and stainless steel 347. The results were compared with those by vacuum fusion method. The difference from gas adsorption in the furnace was not found. The concentration of ^{14}N isotope in the residual gas after the analysis was close to the natural abundance. The analytical results on the standard sample were lower than the values certificated by Kjeldahl method. These results indicated that nitrogen still remained in the melted sample in the crucible. The isotope dilution method enables the selective calibration of gas adsorption. (auth)

26247 CONTINUOUS MOISTURE DETERMINATION OF RAW AND FERTILIZING LIME BASED ON THE METHOD OF NEUTRON MODERATION. Volkhard Netz. Chem. Tech. (Berlin), 17: 95-7(Feb. 1965). (In German)

The applicability of moisture measurements with neutrons was investigated for cruder and fertilizer lime. An arrangement with surface measuring head was selected with consideration of the technology of lime production. The arrangement was used for moisture determination in fertilizer lime. The measurement devices and research conditions are described. It was established that continuous moisture determinations can be made for cruder and fertilizer lime by the neutron moderation method. (tr-auth)

26248 HEALTH PHYSICS APPLICATION FOR SPECTROGRAPHY MONITORING FOR BERYLLIUM IN AIR. J. T. Rozsa (National Spectrographic Labs., Inc., Cleveland), J. Stone, and J. D. Golland. Develop. Appl. Spectry., 3: 243-9(1963).

Methods are given for the determination of trace amounts of Be and its compounds in air, urine, and smear samples by direct-reading emission spectroscopy. The spectrometer monitor used was a 50-cm Ebert type with a reciprocal linear dispersion of 4.1 A/mm. Air samples were collected on Micretain filters that were mounted in sandwich-like coupons; the coupons were supported in a modified Petrey stand between Pt-tipped electrodes. Excitation was obtained with an a-c spark discharge. The Be 3131.04 A line was observed vs undispersed light. The analytical range is 0.4–25 γ Be/m^3 air. Urine samples were concentrated by solvent extraction. The urine was complexed with EDTA and the pH was adjusted with NaOH. Aqueous acetylacetone solution was added and extractions were made with benzene. The urine concentrate was analyzed by a plasma arc method using Ar as the tangential and siphon gases. The analytical line used was Be 2348.61 A. The analytical range is 0.001–0.2 γ Be/ml urine. Smear samples and air samples were also analyzed by the plasma arc method. The filters were decomposed with H_2SO_4, charred, ignited, treated with HF, dried, and taken up with HCl. In the plasma arc no matrix effect was found for Mg, Cu, or Na up to 400 γ/ml; Fe showed no effect up to 1,000 γ/ml. The analytical range is 0.1–100 γ Be per whole smear sample, usually 9 in.^{2} to 1 ft^2. Coefficient of variation values at the 95% confidence level were about 10%. (Public Health Eng. Abstr., 45: (Apr. 1965))

26249 NEUTRON-ACTIVATION OXYGEN MEASURING APPARATUS. Isao Fujii (Tokyo Shibaura Electric Co., Ltd.). Genshiryoku Kogyo, 10: No. 9, 19-26(Sept. 1964). (In Japanese)

A neutron-activation oxygen measuring apparatus was developed; it consists of a Cockcroft-Walton type accelerator, a pneumatic sample transfer system, an automatic normalization device, and a single-channel pulse height analyzer. The Cockcroft-Walton type accelerator used produces 14-mev neutrons (D-T reaction) at a maximum output of 10^{10} neutrons per second. Sample materials (metal, powder, or liquid) are placed in a polyethylene rabbit case for irradiation (12.0-mm dia and 5mm, 10mm, 15mm, or 35mm in length). The neutron reaction used in the method is $O^{16}(n,p)^{16}N$. The ^{16}N(7.35-sec half life) emits gamma rays of 6.13 and 7.13 Mev, which can be measured by a $1\frac{3}{4}'' \times 2''$ well-type NaI(Tl) scintillator and single-channel pulse height analyzer. There is little interference in the reaction and also in the subsequent measurement of the induced N^{16} activity. After irradiation, the case with a sample is sent to the scintillation detector by compressed air, where the count is started automatically. This oxygen-measuring apparatus determines the content of oxygen, irrespective of the chemical formula of the sample material. In the determination of 1 mg of oxygen in a sample material, the error is about ±15%. The determination of oxygen by the method is shown for coals, chemicals (zinc oxide, benzoic acid, sodium oxalate, nickel oxide) and metals (Ti, Ni, Ta, Cu, Al, W, Mo, Zr-alloy, Al-Alloy, stainless-steel). (NSA of Japan)

26250 SILICON ABUNDANCES IN STONY METEORITES BY FAST NEUTRON ACTIVATION ANALYSIS. James R. Vogt and William D. Ehmann (Univ. of Kentucky, Lexington). Geochim. Cosmochim. Acta, 29: 373-83(May 1965).

Silicon was determined in 107 chondrites and 11 achondrites by fast neutron activation analysis. The technique is essentially non-destructive and rapid, less than ten minutes being required for a single analysis. The precision of the silicon determinations, based on four separate analyses of each meteorite, is better than ±3% in most cases and the absolute accuracy for the silicon values listed is probably better than ±5% for most of the determinations. In addition, a classification scheme for the stony meteorites based on chemical composition is given. (auth)

26251 ENVIRONMENTAL CONTROL OF STRONTIUM AND MAGNESIUM IN MYTILUS. J. Robert Dodd (Western Reserve Univ., Cleveland). Geochim. Cosmochim. Acta, 29: 385-98(May 1965).

Portions of the calcite and aragonite shell layers of west coast specimens of the pelecypod Mytilus were analyzed for strontium and magnesium by emission spectroscopy, x-ray fluorescence, and flame photometry. Most specimens came from localities where detailed temperature and salinity records are available. The strontium concentration in the calcitic outer prismatic layer correlates positively with growth temperature. In a given shell the strontium concentration of this layer varies seasonally through successive growth increments. Shell size has a small effect on the strontium concentration of the outer prismatic layer; larger shells have a slightly lower strontium concentration at a given temperature. Salinity variation does not appear to affect the strontium concentration of the outer prismatic layer. The strontium concentration in the aragonitic nacreous layer is negatively correlated with temperature. The magnesium concentration in the outer prismatic layer increases markedly with decreasing salinity and shows a weak positive correlation with temperature. The temperature-magnesium relationship varies between the two species examined in this study. Shell size also has an effect on the magnesium concentration in this layer; intermediate sized (50 mm long) shells have the highest concentration. The magnesium concentration of the

nacreous layer is too low to be effectively measured with the techniques used in this study. (auth)

26252 HELIUM, NEON, ARGON, KRYPTON AND XENON IN GAS EMANATIONS FROM YELLOWSTONE AND LASSEN VOLCANIC NATIONAL PARKS. E. Mazor and G. J. Wasserburg (California Inst. of Tech., Pasadena). Geochim. Cosmochim. Acta, 29: 443-54(May 1965).

The abundance of helium, neon, argon, krypton, and xenon was measured in gas emanations from thermal springs in Yellowstone National Park, Wyoming, and Lassen National Park, California. The determinations were made using an isotope dilution procedure. The isotopic composition of argon and the relative abundances of argon, neon, krypton, and xenon indicate that these gases originated from the atmosphere through dissolution in ground water. Helium was found to be in marked excess, which is attributed to the contribution of juvenile helium from radioactive decay. (auth)

26253 DETERMINATION OF BROMINE CONTENT AND ISOTOPIC COMPOSITION OF BROMINE IN STONY METEORITES BY NEUTRON ACTIVATION. A. Wyttenbach, H. R. von Gunten, and W. Scherle (Eidgenossische Institut für Reaktorforschung, Würenlingen, Switzerland). Geochim. Cosmochim. Acta, 29: 467-74(May 1965).

Activation analysis was used to determine the bromine content of eleven stony meteorites. The values found by this method are appreciably lower than those obtained up to now by conventional chemical analysis. The highest value found is 1.56 ppM and the lowest 35 ppB. Hot water leaches removed considerable amounts of bromine in two samples tested (31 and 88% respectively). The bromine to chlorine ratio in the leach water is essentially the same as in the meteorite; this seems to exclude the possibility of surface contamination of the samples. The ratio of chlorine to bromine content in eleven meteorites varies over two orders of magnitude and depends on the absolute chlorine content. Within the limits of accuracy of the method used, the isotopic composition of bromine in the 5 samples tested seems to be the same as in the case of terrestrial bromine. (auth)

26254 DETERMINATION OF CHLORINE IN STONY METEORITES BY NETURON ACTIVATION ANALYSIS. H. R. von Gunten, A. Wyttenbach, and W. Scherle (Eidgenossische Institut für Reaktorforschung, Würenlingen, Switzerland). Geochim. Cosmochim. Acta, 29: 475-80(May 1965).

The chlorine content of stony meteorites was measured by ^{38}Cl produced by neutron activation. Nine hypersthene chondrites showed chlorine abundances from 27 to 266 ppM with a mean of 114 ppM; two enstatite chondrites contained 222 and 500 ppM, a Soko-Banja type chondrite 57 ppM, and a bronzite chondrite 97 ppM Cl; 2 and 5 ppM Cl were measured in two samples of the enstatite chondrite Norton County. Hot water leaches applied to the irradiated samples, showed for most of the samples that the leachable chlorine was in the order of a few per cent of the chlorine content of the meteorite. An exception of this result was found in the case of the hypersthene chondrite Dhurmsala where about 80% of the chlorine was leachable. (auth)

26255 RADIOGENIC ARGON DETERMINATION BY NEUTRON ACTIVATION ANALYSIS. M. Soroiu, M. Cerei, M. Oncescu, A. Danis, and C. Mantescu (Inst. for Atomic Physics, Bucharest). Geochim. Cosmochim. Acta, 29: 551-61(May 1965).

For the determination of radiogenic argon by means of thermal neutron activation analysis, the argon extracted from the sample is purified with metallic titanium heated at 800°C then slowly cooled to 200°C, after the sample has melted in vacuo. The argon is then collected in a quartz vial, the gas being adsorbed on 0.240 g of charcoal which is cooled at liquid nitrogen temperature. The vial is provided with a bulb in which the charcoal is placed. After the vial is sealed, the charcoal-containing bulb is heated up to 700°C to ensure the desorption of argon from the charcoal, whereupon the bulb is removed from the vial. This is necessary in order to avoid the irradiation of the calcium present in the charcoal with fast neutrons accompanying the thermal neutron fluxes, since the fast neutrons cause the reaction $^{40}Ca(n,\alpha)^{37}Ar$. In this manner, ^{37}Ar results exclusively from the reaction $^{36}Ar(n,\gamma)^{37}Ar$ and can therefore be used for the accurate estimation of the radiogenic argon contamination with atmospheric argon. Similarly, a known quantity of argon of normal isotopic composition is introduced into another quartz vial, identical with the first. Both vials are irradiated for ten hours in a 10^{13} thermal neutrons/cm^2 sec flux. The radioactive argon from the two vials is introduced into two identical Geiger-Müller counters. The radiogenic argon content in the sample is determined by comparing the counting rates of ^{41}Ar and ^{37}Ar in the two counters. Since the volume of the vials in which the gas is collected is small, three sample vials and a standard vial can be simultaneously irradiated. In order to check the method, blank runs were carried out which did not show the presence of ^{41}Ar and ^{37}Ar isotopes. In other vials, known quantities of ^{40}Ar and ^{36}Ar were irradiated. Assuming these quantities as unknown and using for their determination the same process as for the determination of the argon in the samples, the same quantities of argon were found within the usual experimental error limits of 2-3%. The age determinations obtained by this method on a muscovite and on a biotite sample were compared with the age values obtained on the same samples by classical methods. The results of these verifications prove the accuracy of the present method. (auth)

26256 EVALUATION OF THE EFFICACY OF DIFFERENT METAL CHELATES OF DTPA IN REMOVING INTERNALLY-DEPOSITED RADIONUCLIDES. Alexander Catsch, Du Khuong Le, and Danielle Chambault (Kernforschungszentrum, Karlsruhe, Ger.). Intern. J. Radiation Biol., 8: 35-43(1964). (KFK 267)

The effectiveness of Co(II)-DTPA and Zn(II)-DTPA in preventing the retention of radiocerium and radioyttrium by rat organs was studied and found to be insignificantly diminished as compared with Ca-DTPA. The therapeutic index of both chelates, on the other hand was greater than that of Ca-DTPA because of their low toxicity. The possible therapeutic use of these chelates is discussed. (auth)

26257 DETERMINATION OF PICOCURIE CONCENTRATIONS OF IODINE-131 IN MILK. Bernd Kahn (Public Health Service, Cincinnati). J. Agr. Food Chem., 13: 21-4(Jan.-Feb. 1965).

The determination procedure is described. Iodine is made available for beta counting after separation from the resin; it is eluted from the resin, precipitated as silver iodide, washed to remove silver chloride and organic impurities, and then beta-counted. In addition to its application in detecting ^{131}I in the 1 pC/l range, the procedure has been used for simplifying the routine milk-network analysis of ^{131}I and for rapidly estimating ^{131}I in milk at concentrations significant for radiological health action (above 100 pC/l). (P.C.H.)

26258 A HEAT-FLOW PROBLEM IN ELECTRON-BEAM MICROPROBE ANALYSIS. G. S. Almasi, J. Blair, R. E. Ogilvie, and R. J. Schwartz (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 36: 1848-54(June 1965).

In low melting point or low decomposition temperature materials with low thermal conductivity the local heating generated by the electron beam of an electron microprobe induces permanent damage to the sample and thus makes the technique unreliable. An aluminum layer of 1-μ thickness helps to dissipate the heat and lowers the temperature to tolerable levels. The heat-flow problem of the two-layer target, consisting of the sample and the deposited aluminum layer, is analyzed by the method of images, and results are presented for various thicknesses of aluminum. Experimental evidence is presented from HgTe and a Bi-Sb-Te-Se alloy on the usefulness of the method. (auth)

26259 DETERMINATION OF OXYGEN IN BERYLLIUM METAL BY VACUUM FUSION. J Brill and F. Dugain (Compagnie Péchiney, Grenoble, France). J. Nucl. Mater., 16: 162-8(June 1965). (In French)

The procedure for vacuum-fusion analysis of oxygen in beryllium is described. The results obtained were compared with those obtained by activation with rapid neutrons;

the good agreement between the two techniques showed the accuracy of the first technique, which also demonstrated by others. (auth)

26260 X-RAY EMISSION ANALYSIS OF CEMENT RAW MIXTURE BY RADIO-ISOTOPES. Hiroshi Imamura and Kaoru Uchida (Ube Kosan Co., Ltd., Japan). Kogyo Kagaku Zasshi, 67: 1827-31(Nov. 1964). (In Japanese)

CaO, Fe_2O_3, SiO_2, and Al_2O_3 contents in a cement raw mixture were determined by non-dispersive x-ray-emission analysis using radioisotopes with a proportional counter and a pulse height analyzer. Two radioisotopes were used, i.e., a ^3H + Zr soft x-ray source for CaO and Fe_2O_3, and a ^{210}Po alpha source for SiO_2 and Al_2O_3. Each constituent was determined by count of discriminated pulses from a proportional counter. An overlap of SiO_2 and Al_2O_3 spectra was eliminated by an Al-filter. Furthermore, it was found that SiO_2 and Al_2O_3 could be determined by the channel that suppresses the matrix effect of MgO, and SiO_2 could be determined by another channel that suppressed the effect of Al_2O_3 and MgO. After samples are set to the circular plate by melting with $Li_2B_4O_7$ according to Andermann's method, these four constituents can be determined in only 5 min. The accuracy of the method is almost equal to that of the usual x-ray method. (auth)

26261 THE ACTIVATION ANALYSIS OF THE SMALL AMOUNT OF OXYGEN IN MINERAL OILS BY FAST NEUTRONS. Hiromi Yoshida and Yoichi Goshi (Tokyo Shibaura Electric Co., Ltd.). Kogyo Kagaku Zasshi, 67: 1832-5(Nov. 1964). (In Japanese)

A fast neutron activation method was applied to the analysis of oxygen in mineral oils, especially in an insulating oil. A sample (about 4 g) was irradiated in a 14-Mev neutron flux (10^{10} neutrons cm^{-2} sec^{-1}) and the radiation from ^{16}N was counted by a scintillation method. It was found that two corrections were required. The first is the correction of the gradient of the calibration curve, which is due to the matrix effect. The second is due to the background caused by the sample container. Oxygen analysis of several kinds of mineral oil was carried out, and the deviation from the standard was 2.4% in the range of 0.05–0.50%. (auth)

26262 NEUTRON-ACTIVATION ANALYSIS OF IMPURITIES IN GELATIN AND ALUMINA. Tsugio Takeuchi and Daido Ishii (Nagoya Univ., Japan). Kogyo Kagaku Zasshi, 67: 1835-8(Nov. 1964). (In Japanese)

Sodium, manganese and copper in gelatin were determined by measuring γ-ray spectra after irradiation for 2 hr at 3×10^{11} neutrons cm^{-2} sec^{-1} in the atomic reactor (JRR-1). Also traces of sodium, potassium, gallium, and copper in alumina and ammonium alum for manufacturing artificial jewels were determined by measuring γ-ray spectra after irradiation for 20 min. at 4×10^{13} neutrons cm^{-2} sec^{-1} in atomic reactor (JRR-2). This method proved to be useful for the process control analysis of these materials. (auth)

26263 SPECTROPHOTOMETRIC DETERMINATION OF TRACE CONTAMINANTS IN URANIUM(VI) OXIDE. Imrene Csada and Henrik Rausch. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 13: 55-60(1965). (In Hungarian)

The spectrophotometric methods developed for the determination of trace contaminants in the reactor-grade uranium(VI) oxide produced at the Institute are briefly described. To eliminate the interference of uranium with the measurements, precipitation, extraction, and distillation techniques are used. (auth)

26264 ON THE DETERMINATION OF ZIRCONIUM IN STEEL CONTAINING TUNGSTEN BY SPECTRO-PHOTOMETRIC METHOD. Takashi Sakaki (Japan Special Steel Co., Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 29: 151-8 (1965). (In Japanese)

A method was developed for determination of the zirconium content in a steel containing tungsten. The fundamental conditions for spectrophotometric determination of zirconium with xylenol orange was studied. The condition for the separation of zirconium from tungsten by cupferron was examined, and the procedure was decided. The absorption maximum of the xylenol orange complex salt of zirconium is at 545 ~ 550 mμ. However, the relation between the zirconium content (0.00 to 0.30 mg/100 ml) and the absorbance follows Beer's law only at the wavelength of 532 mμ. Therefore, in this experiment, the absorbance was measured at this wavelength. Hydrochloric, nitric, and perchloric acids did not interfere with the formation of the xylenol orange complex salt of zirconium, if these acids were neutralized with ammonium hydroxide. In this method, there was no significant effect from 200 mg of iron, 15 mg each of manganese and molybdenum, 50 mg each of nickel and chromium, 5 mg each of copper and titanium, 0.25 mg of tungsten, 20 mg each of vanadium and cobalt, 80 mg of aluminum, and 2 mg of selenium contained in the separated sample solution. Niobium interfered. The complex salt of zirconium cupferrate was formed quantitatively in a solution of pH 5.0 to 7.5 containing tartaric and oxalic acids. Potassium salt interfered with the formation of the complex salt of zirconium cupferrate, but sodium salt did not. Therefore, the oxides of tungsten and zirconium were fused with sodium pyrosulfate. By means of this separation method with cupferron, zirconium can be separated from tungsten easily and accurately. A method was established by which 0.005 to 1% zirconium in a steel containing tungsten can precisely be measured without difficulty. The zirconium contents in synthetic and actual samples were measured by this method with satisfactory results. (auth)

26265 DETERMINATION OF ZIRCONIUM BY ACTIVATION AND CHEMICAL SEPARATION OF ^{97}Nb. T. K. Choy, H. R. Lukens, and G. H. Andersen (General Dynamics Corp., San Diego, Calif.). Nucl. Appl., 1: 179-83(Apr. 1965).

A rapid, accurate method for determination of zirconium by activation analysis with radiochemical separation is described. After neutron irradiation of the sample, it is dissolved and allowed to stand over 4 hr; then the ^{97}Nb daughter of ^{97}Zr is extracted from the sample solution. A high degree of recovery and separation, especially from hafnium and other elements usually associated with zirconium, is obtained. These features, coupled with high sensitivity, combine to give the method advantages relative to previous procedures for the determination of zirconium. (auth)

26266 ANALYSIS OF ELEMENTS BY GAMMA SPECTROMETRY AFTER NEUTRON IRRADIATION. NOMOGRAPHIC DETERMINATION OF THE DOSAGE LIMITS AND THE INTERFERENCE. W. Haerdi (Université, Geneva). Nukleonik, 7: 58-64(Feb. 1965). (In French)

Analysis by neutron activation underwent rapid development the last few years and gave a different analytical method where the classical chemical or physico-chemical methods of determination were laborious, complicated, or not very sensitive. When it is possible, it is preferable to measure γ radiations, more penetrating and monochromatic, by means of a gamma spectrometer. It is often important to know in advance the limits of determination of an element and to be able to determine the interferences due to accompanying elements, in the sample to be analyzed, activated simultaneously with the element. These two problems can be resolved rapidly by means of the graphic representations proposed. (tr-auth)

26267 RADIOACTIVITY: DETECTION OF GAMMA-RAY EMISSION IN SEDIMENTS IN SITU. David Jennings, Norman Cutshall, and Charles Osterberg (Oregon State Univ., Corvallis). Science, 148: 948-50(May 14, 1965).

A probe for measuring emission of γ rays in sediments in situ in water depths to about 35 meters was used to measure radioactivity in the Columbia River estuary and Oregon coastal areas. This technique offers some advantage over methods in which sediment samples are collected at sea and returned to the laboratory for radioanalysis. (auth)

26268 DETERMINATION OF COMMON IMPURITIES IN NIOBIUM METAL AND OXIDE BY THE POWDER-D.C. ARC TECHNIQUE. LeRoy S. Brooks (E. I. du Pont de Nemours, Wilmington, Del.). Spectrochim. Acta, 21: 1023-7(May 1965).

A method is described for the determination of B, Si, Ti, Cr, Fe, Ni, Zr, Mo, Ta, and W in niobium metal or

oxide analyzed as powdered niobium pentoxide. Dry powder samples are mixed with graphite (or AgCl for the tungsten determination) and excited with a d-c arc. Intensity ratios of specified line pairs are measured photometrically and converted to concentrations of elements sought. The precision, accuracy, and limits of detection are shown in tables. (M.C.G.)

26269 DETERMINATION OF COMMON IMPURITIES IN NIOBIUM METAL BY THE FUSION-D.C. ARC TECHNIQUE. LeRoy S. Brooks (E. I. du Pont de Nemours, Wilmington, Del.). Spectrochim. Acta, 21: 1029-31(May 1965).

A fusion-d-c arc technique for determining B, Si, Ti, Cr, Fe, Ni, Zr, Mo, Ta, and W in niobium or niobium oxide is described. Niobium oxide or metal chips are fused with potassium pyrosulfate in a platinum crucible. The powdered fusion is placed in a graphite cup electrode and excited with a d-c arc. Intensity ratios of the elements to be determined relative to an added germanium internal standard were measured photometrically and converted to concentrations. The accuracy and precision of the method are shown. (M.C.G.)

26270 CONDUCTOMETRIC STUDY ON THE QUANTITATIVE PRECIPITATION OF SAMARIUM(III) AS NORMAL TUNGSTATE. Sarju Prasad and Rajendra Swarup (Banaras Hindu Univ., India). Z. Anal. Chem., 209: 394-7(1965).

Conductometric titrations of samarium nitrate with sodium tungstate were carried out with 30% ethanol concentrations at 25° ± 0.5°C. The breaks were sharp in both the direct and reverse titrations. The method described is an easy titrimetric procedure for the micro-determination of samarium as well as tungstate ions. (auth)

26271 ON THE X-RAY FLUORESCENCE ANALYSIS OF URANIUM AND MOLYBDENUM IN SOLUTION. H. Parthey (Kernforschungszentrum, Karlsruhe, Ger.). Z. Anal. Chem., 209: 398-405(1965). (In German)

A method was developed for the determination of uranium and molybdenum in solution by x-ray fluorescence analysis. Attempts were especially made to determine low contents of one element in the presence of high concentrations of the other and to obtain a high sensitivity. Type and extent of matrix effects were studied. (auth)

26272 ON THE PHOTOMETRIC TITRATION OF FLUORIDES WITH THORIUM NITRATE. Claus Harzdorf and Ottmar Steinhauser (Laboratorium der Farbenfabriken Bayer AG, Leverkusen, Ger.). Z. Anal. Chem., 210: 106-12(1965). (In German)

A recording photometric titration of semimicro quantities of fluoride is described. This method replaces the uncertain visual endpoint of Alizarin S and thorium by an objective record of the terminating color change obtained in titrations of fluoride with thorium nitrate as titrant and morin as indicator. Thus subjective errors were eliminated and precision of fluoride determinations was improved. Fluoride may be determined either directly or after separation by distillation. An efficient distillation apparatus is described. (auth)

26273 COMPLEXES OF METALLOCHROMIC SUBSTANCES. VIII. DETERMINATION OF LANTHANIDES AND YTTRIUM BY MEANS OF DICARBOXYARSENAZO III. B. Budesinsky and K. Haas (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Z. Anal. Chem., 210: 263-70(1965).

Dicarboxyarsenazo III (DCAA III), i.e. 2,7-bis(2′-arsono-5′-carboxyphenylazo)-chromotropic acid, was found to be an excellent spectrophotometric reagent for the determination of lanthanides. The sensitivity of the spectrophotometric determination depended on the atomic weight of the individual lanthanides, and varied from 66,300 cm^2mmol^{-1} (lanthanum) to 85,700 cm^2mmol^{-1} (holmium) in molar absorptivity. (auth)

26274 RADIOLUMINESCENT DETERMINATION OF STYRENE IN POLYSTYRENE AND IN SCINTILLATOR PLASTICS. V. G. Kokoulin. Zavodsk, Lab., 31: 290-2 (1965). (In Russian)

The method of radioluminescent determination of from 0.1 to 6% (wt.) of styrene in polystyrene and plastic scintillators is described. The method was based on the capacity of styrene to quench the radioluminescent solutions of p-terphenyl, excited with cobalt sources. The analysis took 10 to 15 min to complete. The precision of the determination was ±2%. (tr-auth)

26275 MICROSCOPIC DETERMINATION OF CERIUM SULFIDE INCLUSIONS. N. N. Popova, N. I. Butko, and G. L. Shubenko (Ukrainian Scientific Research Inst. of Metallurgy, USSR). Zavodsk. Lab., 31: 327-30(1965). (In Russian)

Etching with reagents was used for exposure of cerium sulfide inclusions. The efficiency obtained for different forms of inclusions, determined by metallographic methods, made it possible to differentiate monophase and complex cerium-containing sulfide inclusions. (tr-auth)

26276 METHODS OF SURVEYING AND MONITORING MARINE RADIOACTIVITY. Report of an Ad Hoc Panel of Experts. (International Atomic Energy Agency, Vienna (Austria)). Safety Series No. 11. 1965. 101p. (STI/PUB/86). $2.00; S42,- (12/-stg; F.Fr.8,-; DM 6.40(IAEA).

A review is presented of technical methods for surveying and monitoring radioactive substances in sea and marine products, which would be needed in the effective control of the radioactive pollution of the sea. Analytical procedures for specific radionuclides are discussed. The physical principles basic to radioactivity measurement are also discussed. (D.L.C.)

26277 MICRO ELEMENT ANALYSIS BY NEUTRON ACTIVATION. Rune Soeremark (Harvard Univ., Boston). p.54-77 of "Progress in Atomic Medicine. Vol. I." New York, Grune and Stratton, 1965.

The determination of micro elements in biological materials by neutron activation is reviewed. The activation method was compared with methods of quantitative analysis. (P.C.H.)

26278 KOINZIDENZTABELLEN DER ATOMSPEKTROSKOPIE. (Coincidence Tables for Atomic Spectroscopy). Josef Kuba, Ludvik Kucera, Frantisek Plzak, Miloslav Dvorak, and Jan Mraz. Prague, Verlag der Tscheschoslowakischen Akademie der Wissenschaften, 1964. 1136p.

The principal lines used in emission spectral analysis with coincidence between 2000 and 10,000 Å are tabulated with a separate tabulation for the rare earths. Supplementary tables for use in the practical utilization of the spectral line tabulation are included. (J.S.R.)

26279 RAPID METHODS OF DETERMINING INTERNAL RADIOACTIVE CONTAMINATION. J. Sedlet, W. D. Fairman, and J. J. Robinson (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, World Health Organization, 1965, Preprint No. SM-56/8, 21p. (CONF-650302-15).

From IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna.

Methods considered for the emergency assessment of internal contamination are: in vivo gamma- and x-ray counting; gamma- and x-ray counting of excretion and blood samples without sample preparation; and radiochemical separations on excretion and blood samples followed by counting. The applicability, limitations, sensitivity, and time requirements of each method are discussed for specific radionuclides, including the actinide elements, the common fission products, low-energy beta emitters, and others. The preferred methods are indicated. A method is considered adequate when it can detect, in a few hours, an intake equivalent to the smallest continuous permissible body burden specified by the ICRP. Although such sensitivity is not always necessary, it should always be sufficient and can usually be obtained. The alpha emitters and the low-energy pure beta emitters present the greatest difficulty since body burdens of these nuclides must ordinarily be determined through radiochemical analysis of blood or excreta. The radiochemical separations developed and used at Argonne National Laboratory for the rapid determination of such

emitters are presented. Some of the problems that arise in obtaining body burdens from excretion rates shortly after intake are also discussed. During this period the excretion pattern changes rapidly and, for many nuclides of interest, at an unknown rate. At very high and very low intakes accurate body burden measurements are not immediately necessary. However, for each radionuclide there is an intermediate intake level at which a reasonably accurate body burden determination is needed early to decide if treatment is warranted. The properties and factors that make the bone-seeking elements particularly difficult to handle in emergencies are discussed. (P.C.H.)

Inorganic and Physical Chemistry

26280 (AERE-R-4769) METHODS OF DECREASING THE EXTRACTION BY PROCESSING SOLVENTS OF NITROSYLRUTHENIUM NITRATO-COMPLEXES FROM NITRIC ACID SOLUTIONS. PART 2. TREATMENT OF AQUEOUS SOLUTIONS WITH NITROUS ACID. D. Scargill and C. E. Lyon (Atomic Energy Research Establishment. Harwell (England)). Mar. 1965. 23p. Dep.; $0.70(BIS); 3s. 6d. (HMSO)

Studies have been made on the preparation of nitrous acid and the rates of formation and decomposition of nitrosylruthenium nitro complexes in nitric acid solutions. A suitable method for the treatment of nitrosylruthenium nitrato complexes with nitrous acid to give a yield of about 90% nitro complexes is given. (auth)

26281 (CEA-R-2596) CINETIQUE DE LA REACTION DE LA VAPEUR D'EAU ET DU DIOXYDE DE CARBONE SUR L'URANIUM. (A Kinetic Study of the Reaction of Water Vapor and Carbon Dioxide on Uranium). Jean-Paul Santon (Commissariat à l'Énergie Atomique, Grenoble (France). Centre d'Études Nucléaires). 1965. 72p. Dep.(mn).

Thesis submitted to Grenoble Univ. (France).

The kinetic study of the reaction of water vapor and carbon dioxide with uranium was performed by thermogravimetric methods at temperatures between 160 and 410°C in the first case, 350 and 1050°C in the second. Three types of uranium specimens were used: uranium powder, thin evaporated films, and small spheres obtained from a plasma furnace. The experimental results led in the case of water vapor, to a linear rate of reaction controlled by diffusion at the lower temperatures, and by a surface reaction at the upper ones. In the case of carbon dioxide, a parabolic law was found, controlled by diffusional processes. (auth)

26282 (CONF-650411-4) SOLUBILITY STUDIES IN ALKALI METALS. [S. S. Blecherman, G. F. Schenck, and R. E. Clearyl] (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Aircraft Nuclear Engine Lab.). Apr. 21, 1965. Contract AT(30-1)-2789. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Joint NASA-AEC Liquid Metals Corrosion Meeting, Gatlinburg, Tenn.

Data scatter difficulties were encountered in the Nb–Li solubility measurements, but data were gathered over the range 760 to 1540°C. The solubility of Nb in purified K was found to be below 20 ppm up to 1200°C, and the effects of O_2 on the solubility at 1095°C were studied. $KNbO_3$ was identified in the products. Preliminary runs on Zr in Li at 1370°C are reported. The solubility of Ca in 22 Na–78 K alloy at 500 to 800°F was determined. (D.L.C.)

26283 . (INP-360) DYNAMIKA ROTACYJNA GRUPY NH_4 W NADCHLORANIE AMONU ORZA GRUPY H_3O W NADCHLORANIE HYDRONU. (Rotational Dynamics of the NH_4 Group in Ammonium Perchlorate and of the H_3O Group in Hydronium Perchlorate). Janina Maria Janik (Institute of Nuclear Physics, Krakow (Poland)). Oct. 1964. 61p. CFSTI.

The rotational dynamics of ammonium groups in NH_4ClO_4 and of hydronium groups in H_3OClO_4 was investigated by using three types of neutron methods, i.e., the double differential scattering cross-section method with the application of a normal and inverted Be-filter, and the total neutron cross-section method. The results obtained were interpreted as giving evidence of a free rotation of NH_4 groups in NH_4ClO_4 and of a hindered rotation of H_3O groups in H_3OClO_4. For H_3OClO_4, the torsional frequency was measured (497 cm^{-1}) and the barrier to rotation height was estimated (1.8 kcal/mol). (auth)

26284 (KFK-279) PHOSPHERHALTIGE IONENAUSTAUSCHHARZE. LITERATURUBERSIGHT. (Phosphorus-Containing Ion Exchange Resins. Literature Review). Hans-Heiko Stamm (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Nov. 1964. 60p. Dep.(mn)

Sixty-seven references on the properties and preparation of phosphorus-containing ion exchange resins are tabulated. An abstract is presented for each reference. (J.S.R.)

26285 . (LADC-6485) VIBRATIONAL SPECTRA, FORCE CONSTANTS, AND BONDING IN MIXED CYANIDE–HALIDE COMPLEXES OF GOLD. Llewellyn H. Jones (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1964]. Contract [W-7405-eng-36]. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Infrared spectra of solid $KAu(CN)_2Cl_2$, $KAu(CN)_2Br_2$, and $KAu(CN)_2I_2$ were observed from 100 to 4500 cm^{-1}. The Raman spectrum of aqueous $KAu(CN)_2Cl_2$ was also observed. The results were combined to calculate valence force constants for the $Au(CN)_2X_2^-$ ions. It was found that substitution of halides for two of the cyanides in $Au(CN)_4^-$ results in a slight lowering of the CN stretching force constant, iodide having the greatest effect and chloride the least. This is explained as arising from a slight decrease in metal-carbon sigma bond strength with perhaps a little increase in metal-ligand pi bonding. The metal-halide force constants decrease considerably in the order $F_{AuCl} > F_{AuBr} > F_{AuI}$ as expected from the increasing size of the halides ions. Nevertheless the iodide ion has the greatest effect on the Au–C–N bond structure indicating that the Au–I bond is more covalent than the others. (auth)

26286 (NASA-CR-213) THEORETICAL VISCOSITIES AND DIFFUSIVITIES IN HIGH-TEMPERATURE MIXTURES OF HYDROGEN AND URANIUM. S. B. Schneiderman (United Aircraft Corp., East Hartford, Conn.). Apr. 1965. Contract NASw-847. 135p.

Coefficients of viscosity and diffusion were calculated for multicomponent mixtures of hydrogen and uranium in order to provide data for use in studies of gaseous nuclear reactor concepts. These properties were calculated for eighteen fuel partial pressure ratios, P_{FUEL}/P, ranging from 0.0 (pure hydrogen) to 1.0 (pure fuel), for nine temperatures from 20,000 to 100,000°K, and for pressures of 100, 500, and 1000 atmospheres. Some of the calculations for pure hydrogen were also performed for a temperature of 10,000°K. The calculated values of viscosity and diffusion coefficients for the multicomponent hydrogen–uranium mixtures were used to calculate the Schmidt number—a dimensionless group which relates the scales of momentum and mass transfer—for each mixture. For values of P_{FUEL}/P greater than approximately 0.03, the Schmidt number was found to be less than unity, thus indicating that, for gradients of the same magnitude in velocity and concentration, mass flux due to diffusion will proceed at a greater rate than momentum flux due to viscosity. For values of P_{FUEL}/P less than approximately 0.03, the Schmidt number exceeded unity, thus indicating a reversal in the relative magnitudes of momentum and diffusive flux. (auth)

26287 (NIJS-R-432) ON THE URANIUM–HYDRAZINE SYSTEM. B. S. Brcic, J. Slivnik, D. Kolar, B. Frlec, M. Komac, and P. Glavic (Nuklearni Institut "Jozef Stefan," Ljubljana (Yugoslavia)). July 1964. 12p. Dep.(mn).

Several reactions of the non-aqueous and aqueous hydrazine with different uranium salts (UF_6, UF_4, $UO_2(NO_3)_2$ etc.) were described which could be possibly used as intermediate steps in the preparation and purification of uranium fuels. The products of the reaction of non-aqueous hydrazine with uranium fluorides (UF_6 and UF_4) were analyzed and compared with the compounds obtained by the reaction of hydrazine fluoride with metallic uranium and uranium

oxide. In the system hydrazine hydrate–uranyl nitrate–water, different precipitates with uranium in (6+) and (4+) valence states were obtained depending on the reaction conditions. The precipitates were decomposed and several uranium oxides were found to be formed during the decomposition process. (auth)

26288 (NP-14872) RAPPORT SUR LA COMPARAISON INTERNATIONALE DE ^{241}Am. (Report on the International Comparison of ^{241}Am). A. Rytz (Bureau International des Poids et Mesures, Sevres (France)). July 1963. 18p. Dep.(mn).

The results of the measurements of ^{241}Am performed by 21 laboratories of the world are tabulated, and the various sources of error are indicated. (J.S.R.)

26289 (NP-15042) BIBLIOGRAPHY ON THE HIGH TEMPERATURE CHEMISTRY AND PHYSICS OF GASES AND GAS-CONDENSED PHASE REACTIONS. No. 14. L. Brewer, comp. (California Univ., Berkeley). Mar. 31, 1965. 23p. Free(NBS, Washington, D. C.).

A total of 199 references is presented, arranged under two categories: reaction between gases and condensed phases, and spectroscopy of interest to high-temperature chemistry. (D.L.C.)

26290 (NYO-2780-1) CONDUCTIVITY STUDIES IN LOW MELTING FUSED SALTS AND ELUCIDATION OF THE PROPERTIES OF POTASSIUM DINITRATOTETRACHLOROCOBALTATE(II) (thesis). Martin Goffman (Temple Univ., Philadelphia, Pa.). May 1965. Contract AT(30-1)-2780. 136p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Various parameters affecting the conductivity of fused salts were examined. These factors were frequency effects, size of the container used, conduction paths through the melt, placement of heaters, and container material. Reasons are given for some of the unusual effects observed. Conductivity and density studies were also performed on some low melting fused salt systems. The solvents used were $(Li,K)NO_3$ eutectic, $(Na,K)NO_3$ eutectic, and KSCN. The effects of addition of alkali metal halides and transition metal compounds to these solvents were also studied. Conductometric titrations to detect complex ion formation in these solvents were performed. Although the minima in these titrations are not strong enough to give definitive proof of complex formation in these systems, a suggestion of complex formation is obtained. An investigation to elucidate the structure of a crystalline precipitate obtained from a molten salt was carried out. An analysis of this precipitate showed the composition to be $K_4CoCl_4(NO_3)_2$. Additional measurements such as magnetic susceptibility measurements, visible reflectance spectra, infrared spectra, and x-ray diffraction data indicate the complex to be the dinitratotetrachlorocobaltate(II) ion. The chlorides were found to lie in the tetrahedral configuration. The nitrate groups are bound to the cobalt ion, but not at a distance close enough to place the cobalt ion in an octahedral field. (auth)

26291 (NYO-7240) THE STUDY OF GASEOUS NEGATIVE IONS FORMED BY ELECTRON IMPACT. Period Covered: December 1, 1957–November 30, 1958. Morton A. Fineman, Americo W. Petrocelli, and Ronald Daignault (Providence Coll., R. I.). Contract AT(30-1)-1670. 74p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

It is shown how Pauling's electronegativity concept can be used to correlate the bond dissociation energies of two sets of compounds, R-Y and R-R, if all the radicals R employ the same bonding atom. An equation was developed for calculating the electronegativity of an element in which the bond energy of the element-element single bond need not be known. Using this equation, the electronegativities of 54 elements and of different oxidation states of 6 elements were computed. The possible alternation of electronegativities in Groups IVB and VB is discussed briefly. Some improvements made in the Lozier apparatus are described. Additional studies on the excited states of the CO^+ ion are reported. Some instrumental difficulties are considered. (D.L.C.)

26292 (SRIA-118) THE CRITICAL TEMPERATURE AND COEXISTENCE CURVE FOR BISMUTH CHLORIDE. Technical Report No. XXIV. J. W. Johnson and Daniel Cubicciotti (Stanford Research Inst., Menlo Park, Calif.). Feb. 26, 1964. Contract AT(04-3)-106. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The critical temperature of $BiCl_3$ was found to be 1178 ± 5°K and the critical density to be 1.210 ± .006 g/cc. The coexistence curve for liquid and vapor was fitted by the equations: $\rho = 1.210 + 1.268\ (1178 - T/1178) \pm 2.347\ (1178 - T/1178)^{1/3}$ (+ for liquid phase; – for vapor phase). These equations are of the same form as those developed by others for Ar, N_2, O_2, CH_4, and CO. It was concluded that bismuth chloride behaves very much like a molecular fluid at least with respect to the critical parameters. (auth)

26293 (SRIA-121) THE BiI_3–I_2 PHASE DIAGRAM. Technical Report No. XXV. Ferenc E. Rosztoczy and Daniel Cubicciotti (Stanford Research Inst., Menlo Park, Calif.). June 2, 1964. Contract AT(04-3)-106. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The BiI_3–I_2 phase diagram was determined. It is of the simple eutectic type, the eutectic composition being very close to pure I_2. The shape of the liquidus is very close to that calculated on the basis that BiI_3 and I_2 are the species in the melt. (auth)

26294 (SRIA-122) THERMODYNAMICS OF VAPORIZATION OF LIQUID THALLOUS BROMIDE AND ITS GASEOUS DIMERIZATION. Technical Report No. XXVI. Daniel Cubicciotti (Stanford Research Inst., Menlo Park, Calif.). June 26, 1964. Contract AT(04-3)-106. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The vapor pressure of liquid thallous bromide was measured by a quasi-static method from the melting point to the boiling point. The results can be represented by the equation: $\log p = -(7324/T) + 22.874 - 4.38 \log T$. The species in the vapor were found to be mainly monomer (TlBr) and some dimer (Tl_2Br_2). The partial pressures of these species were established by combining transpiration measurements with the vapor pressure measurements. Extrapolation of the data indicated that the dimer would constitute about 25% of the vapor at the normal boiling point and about 0.05% at the melting point. The heats of evaporation at 1000°K were 24.3 kcal to monomer and 50 to dimer. The corresponding entropies were 22.0 and 42 eu. (auth)

26295 (TID-21811) THERMODYNAMIC STUDIES OF SOME CHELATES IN MIXED SOLVENTS (thesis). Ahmad Dadgar (Fordham Univ., New York). Mar. 5, 1965. Contract AT(30-1)-906. 113p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

The dissociation constant of acetylacetone and the successive stability constants of metal acetylacetonates were studied at three different temperatures (0, 25, and 40°C) in methanol– and 1-propanol–water mixtures. Additional stability constant data were also obtained at 25°C in ethanol–, 2-propanol–, and dioxane–water mixtures. On the basis of a mathematical model, thermodynamic functions of the dissociation constant and the successive stability constants at constant temperature and constant dielectric constant were defined and evaluated. It was found that if $\log K_1$, $\log K_2$, and $\log \beta$ ($\log \beta = \log K_1K_2$) are plotted against 1/D, similar relationships are obtained. Therefore, a discussion of the results considering any one of the above quantities was sufficient to describe similar trends with the other two. When $\log K_2$ of Ni(II) acetylacetonate was plotted as a function of 1/T, the isodielectric constant lines had nearly the same slope. This indicated that ΔQ^0_D for Ni(II) acetylacetonates was virtually the same for all solvent compositions within a given solvent system (methanol– and 1-propanol–water). Hence, the main contribution to the change in ΔH^0 resulted from the variation of ΔQ^0_T with solvent compositions within a given solvent system. A similar plot for Co(II) acetylacetonate showed greater variations in slope indicating that ΔQ^0_D contributed significantly to the change in ΔH^0. When ΔQ^0_T and ΔS^0_T of acetylacetone were plotted against the corresponding values for the chelates, linear relationships, with the points for Co(II) and Ni(II) being coincidental, were obtained. It was also observed that when $\log K_2$ of Ni(II) acetylacetonate was plotted as a function of 1/D for different solvent sys-

tems, the methanol–and ethanol–water data gave a linear relationship whereas 1-propanol–, 2-propanol–, and dioxane–water data showed a second linear relationship with a different slope. When the pK_D of acetylacetone in mixed solvents was plotted vs. log K_2 data for various metal acetylacetonates, a series of parallel lines was obtained. From the similarity in trends, it was concluded that the influence of the solvent on chelation directly parallels the solvent influence on the ligand dissociation. (auth)

26296 (USNRDL-TR-823) DEVELOPMENT OF A HIGH-TEMPERATURE ISOPIESTIC TECHNIQUE. EQUILIBRATION OF VAPOR FROM RUBIDIUM AND MOLYBDENUM OXIDES WITH VARIOUS NON-VOLATILE OXIDES. C. E. Adams and J. T. Quan (Naval Radiological Defense Lab., San Francisco, Calif.). Jan. 19, 1965. Contracts AT(49-7)-1963 and AT(49-2)-1167. 41p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A modification of the isopiestic method of determining chemical activities in solutions was developed for use with liquid metallic oxides at high temperatures. This method was tested by measuring the uptake of vaporized rubidium and molybdenum oxides by a number of simple oxides and binary oxide systems. The experimental results were used to investigate the interactions and the formation of structural groups among the components of liquid oxide solutions. (auth)

26297 THE OXYCHLORO TECHNETATE(V). B. Jezowska-Trzebiatowska and M. Baluka (Technical Univ., Warsaw). Bull. Acad. Polon. Sci., Ser. Sci. Chim., 13: 1-4 (1965).

The mechanism of the reduction of pertechnetate with HCl and separation of technetium(V) compounds as well as other possible products was investigated. The first product in the reduction was the Tc(V) compound of green color, changing after some time into a golden yellow compound of Tc(IV). At a higher temperature (100°C), the Tc(IV) compound was obtained directly without the intermediate Tc(V). The mechanism of reduction is suggested as being: Tc(VII) + 2e → Tc(V), and Tc(V) + e → Tc(IV). On the basis of the analysis of the olive-green crystals obtained from 600 mg of the green Tc(V) solutions, the formula is proposed as being: $(NH_4)_2$ $TcOCl_5$. The structure and magnetic and spectroscopic properties are also discussed. (P.C.H.)

26298 PREPARATION AND HANDLING OF THE TRANSURANIUM ELEMENTS. K. W. Bagnall. Chem. Brit., 1: 143-5(Apr. 1965).

Twelve transuranium elements were synthesized in the past 25 years. The first 11 complete the second f-transition or actinide group. Their discovery greatly stimulated interest in inorganic chemistry and the development of microchemical and safe-handling techniques. Developments in nuclear power technology renewed interest in thorium and uranium. Much effort was also applied to the separation of radioactive fission products and to problems of their use and safe disposal. Some of the major problems and advances in this field are surveyed. (auth)

26299 PRECIPITATION AND HYDROLYSIS OF URANIUM(VI) IN AQUEOUS SOLUTIONS. III. URANYL NITRATE–SODIUM CARBONATE–STRONTIUM CHLORIDE. H. Fueredi (Inst. "Ruder Boskovic," Zagreb). Croat. Chem. Acta, 36: 195-208(1964).

In the precipitation system uranyl nitrate–sodium carbonate–strontium chloride the influence of changes in concentration of uranyl nitrate on the precipitation of uranium was studied. The concentration maximum was found to occur when the equivalent concentrations of the precipitating components satisfied the following expressions: $[Na_2CO_3] = 1.5[UO_2(NO_3)_2]$ and $[SrCl_2] > 0.7[UO_2(NO_3)_2] - 1.36$. The final pH values of the systems were about 6. It was found that the first expression is valid in the range from 1×10^{-1} to 1×10^{-4} N of uranyl nitrate, while the second expression is valid in the range from 1×10^{-1} to 2×10^{-3} N of uranyl nitrate. The coprecipitation of uranium with strontium carbonate exceeded 85% when the following relations existed between the equivalent concentrations of the precipitating components: $[SrCl_2] \gg [Na_2CO_3]$ and $[Na_2CO_3] \gg 0.76[UO_2(NO_3)_2] + 0.7$. The last expression was found to be valid in the range of 6×10^{-2} to 2×10^{-4} N of uranyl nitrate. The region where more than 85% of uranium was coprecipitated was represented by means of a precipitation body in a coordination system of the concentration of strontium chloride (x axis), sodium carbonate (y axis) and uranyl nitrate (z axis). (auth)

26300 SYNTHESIS AND CRYSTALLOGRAPHIC PROPERTIES OF SINGLE CRYSTALS OF ALKALI URANIUM(V) FLUORIDE COMPLEXES. George D. Sturgeon, R. A. Penneman, F. H. Kruse, and L. B. Asprey (Los Alamos Scientific Lab., N. Mex.). Inorg. Chem., 4: 748-50(May 1965).

Single crystals of fluoride complexes containing pentavalent uranium and an alkali (or ammonium) fluoride were prepared, utilizing anhydrous hydrofluoric acid as a solvent. Finely divided UF_5 was mixed with the desired fluoride, MF(M = Li, Na, K, Rb, Cs, or NH_4), and treated with anhydrous liquid HF. The resulting blue solutions yielded euhedral crystals of MUF_6 compounds, which were suitable for single-crystal x-ray analysis and optical crystallographic measurements. Dimorphism was found with $NaUF_6$; it crystallized in a face-centered cubic form, isostructural with $NaTaF_6$, and in another form which was isostructural with rhombohedral $LiUF_6$. Cell dimensions for rhombohedral $NaUF_6$ are: $a_0 = 6.101 \pm 0.005$ Å and $\alpha = 54° 37'$. Rhombohedral $LiUF_6$, $NaUF_6$, and $CsUF_6$ are blue, optically uniaxial, and have characteristic group absorption spectra at 1.36 μ; KUF_6, NH_4UF_6, and $RbUF_6$ are pale yellow-green optically biaxial, exhibit pseudo-hexagonal x-ray symmetry, and belong to a different spectral class, absorbing at 1.42 μ. (auth)

26301 α-URANIUM PENTAFLUORIDE. I. CHARACTERIZATION. Alexander S. Wolf, John C. Posey, and Karl E. Rapp (Oak Ridge Gaseous Diffusion Plant, Tenn.). Inorg. Chem., 4: 751-4(May 1965). (K-L-6008)

Using uranium hexafluoride as the carrier gas, under sufficient pressure to prevent disproportionation of the uranium pentafluoride, the vapor pressure of this intermediate fluoride was determined by measurement of the transpiration rates over the temperature range from 282 to 412°C. From these data, confirmation of the observed melting point was obtained and the heats of fusion and vaporization were derived. (auth)

26302 α-URANIUM PENTAFLUORIDE. II. A NEW PREPARATION. Alexander S. Wolf, W. E. Hobbs, and Karl E. Rapp (Oak Ridge Gaseous Diffusion Plant, Tenn.). Inorg. Chem., 4: 755-7(May 1965). (K-L-6009)

Based on discovery of the reaction $2UF_6 + 2HBr \rightarrow 2UF_5 + 2HF + Br_2$, a semi-continuous process was developed to prepare UF_5 by this method at a rate of 250 g/hr. The product was a chalky, light blue powder, which was identified as pure, polycrystalline α-uranium pentafluoride. (M.C.G.)

26303 THE REACTION OF XENON WITH DIOXYGEN DIFLUORIDE. A NEW METHOD FOR THE SYNTHESIS OF XENON DIFLUORIDE. Scott I. Morrow and Archie R. Young, II (Thiokol Chemical Corp., Denville, N. J.). Inorg. Chem., 4: 759-60(May 1965).

The reactions of dioxygen difluoride with xenon and krypton at low temperatures were analyzed. No reaction was observed with krypton up to −78°C, where O_2F_2 rapidly decomposed. Xenon, on the other hand, was converted quantitatively to a yellow solid by reaction with a large excess of O_2F_2 at −118°C. When this solid was sublimed at 50°C, high yields of xenon difluoride were obtained. (M.C.G.)

26304 GROWTH OF RARE EARTH SCHEELITES BY THE FLUX METHOD. Michael M. Schieber (Harvard Univ., Cambridge, Mass.). Inorg. Chem., 4: 762-3(May 1965).

Single crystals of scheelites with the formulas $Sr_{0.9}Gd_{0.1}MoO_4$, $Sr_{0.9}Eu_{0.1}MoO_4$, $Na_{0.5}Pr_{0.5}MoO_4$, $Na_{0.5}Tm_{0.5}MoO_4$, $Na_{0.5}Dy_{0.5}TeO_4$, $Li_{0.5}Dy_{0.5}TeO_4$, and $Li_{0.5}Dy_{0.5}MoO_4$ were grown and their unit cell dimensions are reported.

The crystals were grown by slow cooling of a multicomponent solution. (M.C.G.)

26305 SOLUBILITY DIAGRAM OF THE TERNARY SYSTEM $Pr(NO_3)_3$–HNO_3–H_2O AT +25°. K. E. Mironov, E. D. Sinitsyn, and A. P. Popov. Izv. Akad. Nauk SSSR, Ser. Khim., No. 11, 48-54(1964). (In Russian)

Diagrams of $Pr(NO_3)_3$–HNO_3–H_2O solubility at 25°C revealed the presence of pentahydrate nitrate previously not mentioned in published literature. The nitric acid exhibited a dehydrating effect on the pentahydrate of praseodymium nitrate and with the aid of HNO_3 the salt was reduced to the trihydrate monohydrate, and anhydrous praseodymium nitrate salt. The solubility curves constructed for praseodymium and neodymium nitrates showed the two competing processes: the salting out of nitrate by nitric acid and complexing of nitrate with nondissociated acid molecules. The maximum difference of praseodymium and neodymium nitrate solubility at 25°C reached 10 to 12 wt % in 50 to 57% HNO_3 (calculated for anhydrous salt). Optimum acid concentration in the hydrous phase during solvent separation of praseodymium and neodymium nitrates was 62 to 65% HNO_3. (R.V.J.)

26306 THERMOCHEMICAL STUDIES OF URANIUM TETRAFLUORIDE CRYSTAL HYDRATES AND THEIR DEHYDRATION PRODUCTS. E. I. Khanaev and Yu. V. Gagarinskii (Inst. of Inorganic Chemistry, Siberian Academy of Sciences, Novosibirsk). Izv. Akad. Nauk SSSR, Ser. Khim., No. 11, 63-8(1964). (In Russian)

Studies of the heat of hydration of uranium tetrafluoride crystals of rhombic, cubic, and monocline syngony showed that the crystals dehydrated to $UF_4 \cdot 0.5H_2O$ with heats of hydration of 9.25, 3.98, and 2.11 k cal/mole, respectively. Hydration of rhombic and monoclinic syngony crystal hydrates below $UF_4 \cdot 0.5H_2O$ formed a cubic syngony phase retained in successive hydrations. Cubic syngony crystal hydrates formed by hydration of anhydrous tetrafluoride, produced by hydration of $UF_4 \cdot 2.5H_2O$ contained up to 2 moles of water per one mole of UF_4. Hydration of a cubic syngony crystal hydrate, $UF_4 \cdot 0.5H_2O$, did not alter the crystalline lattice. However, the crystal was not capable of being hydrated to the initial state. (R.V.J.)

26307 THE CHEMICAL BOND IN RARE EARTH HEXABORIDES. G. V. Samsonov, Yu. B. Paderno, and E. E. Vainshtein (Inst. of Inorganic Chemistry, Siberian Academy of Sciences, SSR and Inst. of Metal Ceramics and Special Alloys, Ukrainian Academy of Sciences, Kiev). Izv. Akad. Nauk SSSR, Ser. Khim., No. 11, 78-84(1964). (In Russian)

Studies of rare earth hexaboride structure and properties showed that the crystalline lattice of hexaborides can be considered as a simple lattice of metal atoms centered by an octahedron of boron atoms (which deform the lattice) or as a simple cubic lattice of complex boron atoms with the metal atoms freely distributed in it. The electric and magnetic properties related to the electron energy state are determined by the metal forming the hexaboride and vary strongly from one hexaboride to another. The properties related to the normal oscillations of atomic complexes in the lattice (melting temperature, hardness, etc.) are determined by the hard structural body of boron atoms and do not depend on the properties of the metal forming hexaborides. (R.V.J.)

26308 PHYSICO-CHEMICAL STUDIES OF $ScCl_3$–MCl. PART II. MELTING DIAGRAM OF THE SYSTEM KCl–$ScCl_3$. N. Ya. Fedorov and E. S. Petrov (Chemical and Metallurgical Inst., Siberian Academy of Sciences, Novosibirsk). Izv. Akad. Nauk SSSR, Ser. Khim., No. 11, 154-5(1964). (In Russian)

Melt diagrams were constructed for 31 samples of the KCl–$ScCl_3$ system with 0 to 90.6% ScCl. The basic curves of the diagram indicated formation of two chemical compounds: 3 KCl · $ScCl_3$, which melted congruently at 818°C and 2 KCl · $ScCl_3$, which melted incongruently with peritectic disintegration reactions at 473°C. (R.V.J.)

26309 EQUILIBRIUM IN AQUEOUS SOLUTIONS OF URANIUM THIOCYANATE COMPLEXES. V. P. Vasil'ev and P. S. Mukhina (Ivanov Inst. of Chemistry and Tech., USSR). Izv. Vysshykh Uchebn. Zavedenii, Khim. i Khim. Tekhnol., 7: 711-14(1964). (In Russian)

The stability constants and the molar coefficients of the extinction of uranium thiocyanate complexes were determined in the presence of ion intensities of 2.5 and 4 and at 22 to 23°C. The equilibrium diagrams and the optical density diagrams were calculated in aqueous solutions of thiocyanate complexes of uranium. The thermodynamic constants of some thiocyanate complexes were determined and the values of their standard isobaric potentials in aqueous solutions were calculated. (tr-auth)

26310 SECONDARY DEUTERIUM ISOTOPE EFFECTS ON THE STABILITY OF THE SILVER ION–OLEFIN COMPLEXES. R. J. Cvetanovic, F. J. Duncan, W. E. Falconer, and R. S. Irwin (National Research Council, Ottawa). J. Am. Chem. Soc., 87: 1827-32(May 5, 1965). (NRC-8433)

The pronounced secondary deuterium isotope effects on the stability of the electron donor–acceptor complexes between olefins and silver ions, reported previously, were studied in greater detail. Experiments with specifically deuterated propylenes showed that the isotope effect is much larger when deuterium is directly bound to the unsaturated carbon atoms ("α-effect") than when it is in β-position to the double bond ("β-effect"). Both effects were "inverse": deuteration led to an increase in complex stability. The isotope effect was logarithmically additive and approximately independent of the degree of alkyl substitution in the olefin. Enthalpies and entropies of formation were determined for several silver ion–olefin complexes in ethylene glycol solutions in the temperature interval from 0 to 40°C. (auth)

26311 THORIUM DICARBIDE— LOW TEMPERATURE THERMODYNAMIC PROPERTIES. Yoichi Takahashi, Edgar F. Westrum, Jr. (Univ. of Michigan, Ann Arbor), and Richard A. Kent. J. Chem. Eng. Data, 10: 128-9(Apr. 1965). (COO-1149-11)

The heat capacity of thorium dicarbide was measured by adiabatic calorimetry from 5 to 350°K and was found to be of normal sigmoid shape without transitions or thermal anomalies. At 298.15°K, the measured heat capacity at constant pressure (C_p), the practical entropy (S^0), and the Gibbs function $[-(G^0-H_3^0)/T]$ are 13.59, 16.42, and 8.18 cal (gfm °K)$^{-1}$. (auth)

26312 ZIRCONIUM TETRAFLUORIDE— HEAT CAPACITY AND THERMODYNAMIC PROPERTIES FROM 5° TO 307°K. Edgar F. Westrum, Jr. (Univ. of Michigan, Ann Arbor). J. Chem. Eng. Data, 10: 140-2(Apr. 1965).

The heat capacity of ZrF_4 was determined from 5 to 307°K by adiabatic calorimetry. No thermal anomaly was detected and a normal sigmoid curve represents the data. The heat capacity (C_p), entropy (S^0), enthalpy function $[(H^0-H_3^0)/T]$, and free energy function $[-(F^0-H_3^0)/T]$ are, respectively 24.79, 25.00, 14.03, and 10.97 cal/(gfm °K) at 298.15°K. (auth)

26313 EFFICIENCY OF Eu^{3+} FLUORESCENCE IN OXYGEN-DOMINATED HOST LATTICES. Hans J. Borchardt (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Chem. Phys., 42: 3743-5(June 1, 1965).

The efficiency of Eu^{3+} fluorescence in a variety of rare earth oxygen-dominated host materials was measured following excitation by 2537 Å uv radiation at 25°C. It was found to be of the same order as that of the commercial phosphor, magnesium arsenate: Mn in all such hosts. To account for the high efficiency and particularly for the insensitivity of efficiency to the nature of the host lattice, it is proposed that europium–oxygen states are excited directly and that the corresponding absorbtion coefficient is of a magnitude to make this the dominant absorption process. Preliminary work on this subject appears as NSA 17: 18939. (auth)

26314 SPECTRAL INTENSITIES OF THE TRIVALENT LANTHANIDES AND ACTINIDES IN SOLUTION. I. Pr^{3+}, Nd^{3+}, Er^{3+}, Tm^{3+}, AND Yb^{3+}. W. T. Carnall, P. R. Fields, and B. G. Wybourne (Argonne National Lab., Ill.). J. Chem. Phys., 42: 3797-3806(June 1, 1965).

The experimentally measured intensities of the solution absorption spectra of Pr^{3+}, Nd^{3+}, Er^{3+}, Tm^{3+}, and Yb^{3+} in three different solvents were correlated with a theoretical expression derived by Judd. The expression, $P = \Sigma T_\lambda \sigma (f^N \psi \| U^{(\lambda)} \| f^N \psi' \gamma')^2$, where $\lambda = 2, 4, 6$, was derived from a theory in which the ligand-field interactions with the central 3+ ion cause a mixing of higher configurations of opposite parity into the f^N configuration and gives rise to induced electric-dipole transitions. A prerequisite for the intensity calculations was the computation of complete intermediate coupling eigenvectors for the energy levels investigated. Other possible mechanisms such as magnetic-dipole and electric-quadrupole transitions were considered. The oscillator strengths of important magnetic-dipole transitions were tabulated. The results gave the first experimental verification of the ability of the theory to account for large changes in certain bands of the same lanthanide observed in different solvents. Conclusions were drawn respecting the T_λ's obtained in a given medium for all the lanthanides studied, and also for those obtained for a given lanthanide in different media. The J dependence of the T_λ's was removed to facilitate their intercomparison, and the resulting parameters were tabulated. The T_λ's for Yb^{3+} were obtained by an extrapolation of the values computed for Tm^{3+} and Er^{3+}. The nature of the model required by the theory is discussed. (auth)

26315 HEAT OF FUSION OF SOLID PARAHYDROGEN. Robert F. Dwyer, Gerhard A. Cook, Bruce M. Shields, and Donald H. Stellrecht (Union Carbide Corp., Tonawanda, N. Y.). J. Chem. Phys., 42: 3809-12 (June 1, 1965).

The heat of fusion of solid parahydrogen was measured at pressures above that of the triple point. The measurements were carried out up to a pressure of 338 atm. The heat of fusion was found to be a linear function of the pressure, and its values were well reproduced by the equation $\Delta H_f = 0.04415\ P + 28.04$, in which ΔH_f is the heat of fusion in calories per gram mole and P the pressure in atmospheres. The value given by this equation for the triple point of hydrogen is 28.04, which compares with literature values of 28.03, 28.08, and 28.3 cal/mole. A few independent measurements were also made of temperatures corresponding to various pressures along the melting line for parahydrogen; most of the measured temperatures agreed within 0.1°K of those previously reported in the literature. (auth)

26316 EFFECT OF CHEMICAL COMBINATION OF THE X-RAY K EMISSION SPECTRA OF OXYGEN AND FLUORINE. David W. Fischer (Air Force Materials Lab., Wright-Patterson AFB, Ohio). J. Chem. Phys., 42: 3814-21 (June 1, 1965).

Band shapes, wavelengths, and intensities are presented and discussed for the K emission spectra of oxygen and fluorine from some simple oxides and fluorides. It is shown that band shapes and peak positions are dependent on the target material from which they are emitted. Evidence is presented illustrating that this dependence is in part due to such solid-state properties as crystal structure, valence, and coordination. Results were obtained using a flat-crystal vacuum spectrometer with a thin window flow proportional counter and electron excitation. (auth)

26317 DEUTERON MAGNETIC RESONANCE IN DEUTERATED POLYCRYSTALLINE AMMONIUM CHLORIDE AND SULFATE. Sherman W. Rabideau and Peter Waldstein (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 42: 3822-5 (June 1, 1965). (LA-DC-6927)

Values of the quadrupole coupling constants $|eQq|/h$ obtained at the temperature of liquid nitrogen for powdered specimens of deuterated ammonium sulfate and ammonium chloride were found to be 161.9 ± 0.3 and 175.7 ± 0.7 kc/sec, respectively. Absolute values of the asymmetry parameter were estimated to be less than 0.2 from the powder spectra of the two salts. To obtain the deuteron quadrupole split spectrum of ND_4Cl at liquid-nitrogen temperature, it was found to be necessary to use very low r-f field levels and also to irradiate the sample with a ^{60}Co source to reduce the spin-lattice relaxation time. Second-moment measurements were made on the single-line spectrum of ND_4Cl between room temperature and –83°C, from which an activation energy for rotational motion of the ND_4^+ ion was calculated to be 5.0 ± 0.5 kcal/mole. At the temperature of the ferroelectric phase transition in $(ND_4)_2SO_4$, a significant alteration of the electric field gradient was revealed by the change in the separation of the peaks in the five-line deuteron magnetic resonance spectrum. (auth)

26318 NEW RYDBERG SERIES IN MOLECULAR OXYGEN NEAR 500 Å. K. Codling and R. P. Madden (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 42: 3935-8 (June 1, 1965).

Previously unknown resonances in the continuous photoionization absorption of molecular oxygen were observed spectroscopically in the 500 to 600 Å region, using a 180-Mev electron synchrotron as a background source. These resonances formed four Rydberg series, two converging to a level in O_2^+ at 24.564 (±0.004) ev, the others converging to a level in O_2^+ at 24.754 (±0.004) ev. The resonances were caused by high-lying autoionized states of neutral oxygen; the transitions involved the excitation of an inner $\sigma_u 2s$ electron to outer $ns\sigma$ or $nd\pi$ orbitals. This work confirmed the LeBlanc analysis of the Hopfield emission bands at 2100 Å, as being due to transitions in O_2^+. (auth)

26319 CRYSTAL FIELD OF SOME MONOCLINIC RARE-EARTH CHLORIDES. Ian H. Harrop (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 42: 4000-10 (June 1, 1965).

The 15 crystal-field parameters $B_k^q = \langle r^k \rangle A_k^q$ for monoclinic $ErCl_3 \cdot 6H_2O$ were found to be $B_2^0 = 116$, $B_2^2 = 158$, $\overline{B}_2^2 = -262$, $B_4^0 = -88$, $B_4^2 = -193$, $\overline{B}_4^2 = 346$, $B_4^4 = 332$, $\overline{B}_4^4 = 158$, $B_6^0 = -9.8$, $B_6^2 = -70$, $\overline{B}_6^2 = 141$, $B_6^4 = 238$, $\overline{B}_6^4 = -119$, $B_6^6 = 238$, and $\overline{B}_6^6 = -11$. When used with Wybourne's free-ion wavefunctions, the field adequately explained most of the observed Stark and Zeeman splittings. The B_k^q, modified by the calculated $\langle r^k \rangle$ of Freeman and Watson, were appropriate for several ions and, in all, accounted for about 200 independent data. A possible systematic variation of the A_k^q for odd and even electron ions is pointed out. The Zeeman splittings of the $^6P_{7/2}$ and $^6P_{5/2}$ states of $GdCl_3 \cdot 6H_2O$ are explained, and the use of the Gd^{3+} ion as a crystal-field probe is discussed. (auth)

26320 INDUCED INFRARED ABSORPTION OF SOLUTIONS OF H_2 AND D_2 IN LIQUID NEON. George E. Ewing (Indiana Univ., Bloomington) and Sandor Trajmar. J. Chem. Phys., 42: 4038-46 (June 1, 1965).

The induced infrared absorption spectra of solutions of H_2 and D_2 in liquid neon (27.2°K) were studied. Absorption features were found, which differed by less than 7 cm^{-1} from frequencies of vibration rotation transitions expected for the freely rotating H_2 or D_2 molecule. Rotatory energy levels of H_2 and D_2 in neon solution are, therefore, essentially the same as for gas-phase molecules. Evidence for quantized translational energy levels for the solute was found. Broad absorption features, which shifted in frequency with isotope change in solute were assigned to vibration–translation combination bands in which the H_2 (or D_2) molecule, in addition to increasing its vibrational level, increased its translational level in its solvent cage. The spectroscopic determination of quantized-translational energy levels permitted the estimation of a solute–solvent interaction potential. A harmonic-oscillator potential to describe the intermolecular interaction was consistent with the observation that the translational energy levels for D_2 in neon were $\sqrt{2}$ smaller than those of H_2 in neon. This quadratic potential was also in order-of-magnitude agreement with the potential calculated from the Lennard-Jones and Devonshire cell model of the liquid state. The problems of quantitative determination of translational energy levels from spectroscopic data are discussed. This study provided a spectroscopic estimate of the liquid-state interaction potential for the H_2 and D_2 neon system and an approximate evaluation of all the types of energy of the solute: vibration, rotation, and translation. (auth)

26321 DETERMINATION OF THE GROUND ELECTRONIC STATE OF LaO GAS. Leo Brewer and R. M.

Walsh (Univ. of California, Berkeley). J. Chem. Phys., 42: 4055-7(June 1, 1965). (UCRL-11960)

A method of establishing the ground electronic state by observation of absorption in a molecular beam at a sufficient distance from the source was applied to a molecular beam of LaO, which was generated by heating a mixture of La metal and La_2O_3 in a tantalum Knudsen cell, with a rectangular orifice 1-mm wide and 10-mm long. Results established the level of LaO designated as $X^4\Sigma$ as the ground state. (M.C.G.)

26322 NONISOTHERMAL CHEMISORPTION OF HYDROGEN ON TUNGSTEN. R. W. Heimburg and S. L. Soo (Univ. of Illinois, Urbana). J. Chem. Phys., 42: 4058-9 (June 1, 1965).

Flash-filament measurements of the steady-state amount of hydrogen on a 10-in.-long, 0.001-in.-dia tungsten wire were made at 2×10^{-8} Torr for gas temperatures from 77 to 273°K with filament temperatures from 300 to 650°K. For constant incident flux it was found that the amount of hydrogen adsorbed, though strongly dependent on surface temperature was independent of gas temperature. If k_1 and k_2 are defined as the rate constants for chemisorption and desorption from the precursor state, respectively; η as the condensation coefficient; and k_1' as the rate constant for transition from the chemisorbed state to the precursor state; the steady-state concentration of chemisorbed atoms, n_c, is given by $(n_c^0)^2 = \eta(k_1/k_2k_1')n_G(kT/2\pi m)^{\frac{1}{2}}$, where T, m, and n_G are the temperature, mass, and concentration, respectively, of H_2 molecules in the gas phase. (M.C.G.)

26323 LIQUID-SOLID PHASE EQUILIBRIA IN THE HYDROGEN-DEUTERIUM SYSTEM. David White and J. R. Gaines (Ohio State Univ., Columbus). J. Chem. Phys., 42: 4152-8(June 15, 1965).

The phase behavior of mixtures of parahydrogen and normal deuterium, in the liquid and solid states, was investigated. The calorimetric data showed a continuous range of solid solutions from 8°K to the melting points. In the liquid-solid two-phase region the system can be characterized by a continuous series of liquid and solid solutions. The experimental data showed no evidence of the phase separation in the solid state previously reported by Kogan, Lazarev, and Bulatova. (auth)

26324 PHOTOLUMINESCENCE OF LANTHANIDE COMPLEXES. IV. PHOSPHORESCENCE OF LANTHANUM COMPOUNDS. J. S. Brinen, F. Halverson, and J. R. Leto (American Cyanamid Co., Stamford, Conn.). J. Chem. Phys., 42: 4213-19(June 15, 1965).

The phosphorescence spectra were obtained for several lanthanum tris-chelates, and these data were used to locate the lowest triplet levels of the ligands. The triplet levels showed a steady progression in energy, with differing singlet–triplet splittings for various ligands. (auth)

26325 REVERSIBLE PHOTOTRANSFER OF ELECTRONS BETWEEN RARE-EARTH IONS IN CaF_2. Benjamin Welber (IBM Watson Research Center, Yorktown Heights, New York). J. Chem. Phys., 42: 4262-4(June 15, 1965).

A charge-transfer phenomenon occurring between divalent and trivalent ions incorporated into the CaF_2 lattice is described. It is shown that, in one of the two cases considered, the phenomenon is reversible at 4°K. (auth)

26326 EMPIRICAL CORRELATIONS AMONG MONOHYDRIDE BOND LENGTHS. Carol E. Jentelson and S. M. Blinder (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 42: 4306-7(June 15, 1965).

A log-log plot of X-H equilibrium internuclear distance vs atomic number exhibited linearity for the monohydrides of first- and second-row elements. Although the heavier monohydrides fell into a regular pattern according to period, there was considerable scatter from any linear relationship. (M.C.G.)

26327 ABSORPTION SPECTRA OF ZIRCONIUM AND HAFNIUM DIOXIDES. D. Conlon and W. P. Doyle (University Coll., Dublin). J. Chem. Phys., 42: 4315(June 15, 1965).

Optical absorption in thin films of zirconium and hafnium was measured in the region from 200 to 1000 mμ, and the data are shown. The absorption threshold of ZrO_2 was at about 230 mμ and the absorption rose rapidly to the limit of the measurements at 205 mμ. The main features of the spectrum of HfO_2 were the threshold at 330 mμ and the shoulder around 240 mμ, after which the absorption rose rapidly to 205 mμ. (M.C.G.)

26328 EXCHANGE REACTIONS OF OXIDES. PART VIII. THE HOMOMOLECULAR EXCHANGE OF CARBON MONOXIDE. E. R. S. Winter (John & E. Sturge Ltd., Birmingham, Eng.). J. Chem. Soc., Suppl. 1, 5781-99 (1964).

The homomolecular exchange reaction, $^{12}C^{18}O + {}^{13}C^{16}O \rightleftharpoons {}^{12}C^{16}O + {}^{13}C^{18}O$, occurred readily at around room temperature or below on many oxides. Refractory oxides (Nb_2O_5, SiO_2, Al_2O_3) and also Na_2O, TiO_2, and GeO_2 were of low or zero activity but many others were highly active. The activity of NiO depended on the method of its preparation and on the lithium or chromium content; superficial films of oxide upon the metal, e.g., Ni–NiO, Cu–Cu_2O, or Fe–Fe_2O_3, were abnormally active. The metals Ag, Cu, Pd, Pt, Fe, and Ni were studied: the first two were inactive and the activity of the others increased in the order given: nickel was rapidly poisoned by formation of $Ni(CO)_4$. Finely-divided sodium chloride was inactive, as were Cu–CuCl, ZnF_2, and graphite. The amount of carbon monoxide adsorbed under reaction conditions is reported for all active oxide catalysts. A small amount of ^{18}O-exchange between the carbon monoxide and the surface occurred with the active oxides: in general this took place at the same speed as the homomolecular reaction and stopped when that reaction reached equilibrium: the two reactions are accounted for by postulating a small number of immobile sites where the basic reaction is $CO(g) + nO^{2-}(s) \rightleftharpoons CO^{2n-1}_{n+1}(s)$. (auth)

26329 THERMODYNAMIC STUDY OF THE OXIDES OF UO_{2+x}. Paul Gerdanian and Maurice Dode (Universite de Paris, Saclay, France). J. Chim. Phys., 62: 171-84 (Feb. 1965). (In French)

The reasons leading to a new thermodynamic study of the compounds UO_{2+x} by the method of physico-chemical equilibria between an oxido-reducing gaseous phase and the oxide are summarized. The experimental techniques used to determine with precision the emissions from the solid phase are described. Mixtures of H_2 and H_2O were first used, but these did not allow true equilibria to be attained. Equilibrium was obtained with mixtures of CO and CO_2. The isotherms giving log P_{O2} in equilibrium with the oxides UO_{2+x} were determined at 903, 1000, and 1100°C for the composition region between O/U = 2 and O/U = 2.15. (tr-auth)

26330 ISOTOPIC EFFECT OF SULFUR DURING THE OXIDATION OF SULFUR DIOXIDE IN SULFURIC MEDIUM AND THE MECHANISM OF THIS OXIDATION. Pierre Courvoisier, Elisabeth Maurette, and Jean Ravoire (CEN, Saclay, France). J. Chim. Phys., 62: 219-21(Feb. 1965). (In French)

Studies were made to determine if nitrous oxide can catalyze the exchange reaction of sulfur between sulfur dioxide and sulfuric acid. During oxidation of the dioxide the vapor phase was impoverished in heavy sulfur. But the experiments made with labeled sulfuric acid $H_2{}^{35}SO_4$ showed that the sulfur is not exchanged at a measurable rate at room temperature. The isotopic fractionation observed can not be explained by an evolution toward thermodynamic equilibrium. The absence of exchange was interpreted in the light of the mechanisms proposed for the catalytic oxidation of sulfur dioxide. (tr-auth)

26331 THE SPECTRA OF H_2O AND D_2O IN THE VACUUM ULTRAVIOLET. S. Bell (Agricultural and Mechanical Univ. of Texas, College Station). J. Mol. Spectry., 16: 205-13(May 1965).

Vibrational analyses are made of two band systems of water vapor with origins at 1240 and 1219 Å. The fundamental frequencies of H_2O and D_2O were determined for the excited electronic states of both systems. Franck-

Condon calculations based on estimated intensities yielded increases in geometrical parameters of $\Delta r = 0.065$ Å and $2\Delta\alpha = 5.2°$ for the 1240-Å system, and $\Delta r = 0.067$ Å and $2\Delta\alpha = 8.5°$ for the 1219-Å system. (auth)

26332 MORE WAVELENGTHS FROM THORIUM LAMPS. William F. Meggers and Robert W. Stanley. J. Res. Natl. Bur. Std., 69A: 109-18(Mar.-Apr. 1965).

To supplement or supersede the spectroscopic secondary standards of wavelength derived since 1910 from an iron arc interferometric determinations of wavelengths emitted by a thorium lamp were previously reported. Those determinations were restricted to 222 intense radiations of thorium with wavelengths ranging from 3288.7356 to 6991.5839 Å. Now the same, and additional, interference spectrograms were measured to provide wavelengths for 510 radiations ranging in wavelength from 3269.6089 Å to 7020.504 Å. The list includes many lines of lower intensity than those previously published and fills most of the large intervals in the first report. The accuracy in relative wavelength values of 163 classified thorium lines was tested by the combination principle, which indicated that the average error is less than 1 part in 20 to 40 million. Similar measurements of wavelengths emitted by iron halide lamps had errors that are 3 to 5 times greater. (auth)

26333 REPORT ON THE CHEMISTRY OF THE ELEMENTS NIOBIUM AND TANTALUM. XLIII. COMPOUNDS OF NIOBIUM WITH P, As, Sb, S, Se, Te. SYNTHESIS AND CHEMICAL TRANSPORT. Harald Schaefer and Werner Fuhr (Universitat, Munster, Ger.). J. Less-Common Metals, 8: 375-87(June 1965). (In German)

The compounds NbAs, $NbAs_2$, Nb_3Sb, Nb_5Sb_4, and $NbSb_2$ were made from the elements in the presence of I_2 and then transported via the gas phase in a temperature gradient. The lattice parameters agreed with those given in the literature. The sulfides, selenides, and tellurides could also be obtained as well-formed crystals by chemical transport reactions. In all of the NbX_n-systems the X-poor compounds migrated into the hotter and the X-richer into the cooler zone of the reaction-space. This result was considered thermodynamically reasonable. In this manner good preparative separations are possible. (auth)

26334 REPORT ON THE CHEMISTRY OF THE ELEMENTS NIOBIUM AND TANTALUM. XLV. Ta_6I_{14}. PREPARATION, PROPERTIES, STRUCTURE. Dietrich Bauer, Hans Georg Schnering, and Harald Schaefer (Universität, Munster, Ger.). J. Less-Common Metals, 8: 388-401(June 1965). (In German)

Ta_6I_{14}, previously unknown, was obtained as pure crystals by reaction of gaseous TaI_5 with Ta in a temperature gradient. The compound is characterized by its chemical and magnetic behavior (temperature-independent paramagnetism). The d-values are given. The orthorhombic unit cell of Ta_6I_{14} (D_{2h}^{18}-Bbam; a = 14.445, b = 12.505, c = 15.000 Å) contains 4 formula units. The crystal structure was determined by means of Patterson- and Fourier-synthesis along [100], [010], and [001]. Characteristic of the structure is the $[Ta_6I_{12}]$-group. Ta_6I_{14} is isotypic with Nb_6Cl_{14}. (auth)

26335 α- AND β-RUTHENIUM TRICHLORIDE. K. R. Hyde, E. W. Hooper, J. Waters, and J. M. Fletcher (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Less-Common Metals, 8: 428-34(June 1965).

Published information on ruthenium trichloride is discrepant and confusing. Although two forms of the compound are recognized, the means of preparing each in a pure form and of rigorously establishing the purity of each form were lacking. A detailed physico-chemical examination of the materials produced during a systematic reinvestigation of the chlorination of ruthenium metal led to the development of methods for the preparation of pure α- and β-$RuCl_3$. The properties of the two forms and their relation to each other are described. (auth)

26336 THE THERMAL CONDUCTIVITY OF TECHNETIUM. D. E. Baker (Battelle Memorial Inst., Richland, Wash.). J. Less-Common Metals, 8: 435-6(June 1965).

Technetium was recovered from fission-product wastes and reduced to pure metal. The thermal diffusivity from room temperature to 575°C was measured on a 0.12-cm-thick wafer. The thermal conductivity was calculated from these measurements. Data are presented in a graph. (M.C.G.)

26337 THE HEAT CAPACITY AND THERMODYNAMIC PROPERTIES OF HYPOSTOICHIOMETRIC THORIUM DICARBIDE FROM 5 TO 350°K. Edgar F. Westrum, Jr. (Univ. of Michigan, Ann Arbor), Yoichi Takahashi, and Norman D. Stout. J. Phys. Chem., 69: 1520-4(May 1965). (COO-1149-21)

The heat capacity of arc-melted buttons of hypostoichiometric thorium dicarbide determined by adiabatic, cryogenic calorimetry has a normal sigmoid temperature dependence without transitions or thermal anomalies. Values of the heat capacity at constant pressure (C_p), the entropy (S^0), and the Gibbs energy function ($-[G^0 - H_0^0]/T$) are 13.55, 16.38, and 8.168 cal/g.f.m. °K), respectively, at 298.15°K. The standard entropy and enthalpy of formation for $ThC_{1.93}$ at this temperature are 1.0 ± 0.3 cal/(g.f.m. °K) and -31.2 ± 4.0 kcal/g.f.m. (auth)

26338 SELF-DIFFUSION AND STRUCTURE IN MOLTEN GROUP II CHLORIDES. J. O'M. Bockris, S. R. Richards, and L. Nanis (Univ. of Pennsylvania, Philadelphia). J. Chem., 6927-37(May 1965).

Self-diffusion coefficients of both cations and anions in molten NaCl, KCl, $CaCl_2$, $SrCl_2$, $BaCl_2$, $ZnCl_2$, $CdCl_2$, and $HGCl_2$ were measured at constant pressure as a function of temperature over a range of 200°C using the "diffusion-into-the-capillary" technique. The results were corrected for hydrodynamic end error (Δl effect). $D^* = D_D^* \exp(-E_D^*/RT)$ was applicable to all salts except $ZnCl_2$. For $ZnCl_2$, log D_D^* vs. 1/T exhibited curvature. The data were used to test the degree of applicability of several models for liquids. The heats of activation could be predicted from a version of the hole model. Indications concerning structural particles present were deduced from considerations of deviations from the Stokes-Einstein and Nernst-Einstein relationships. (auth)

26339 THE NEPTUNIUM–HYDROGEN SYSTEM. R. N. R. Mulford and T. A. Wiewandt (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem., 69: 1641-4(May 1965). (LA-DC-6738)

Pressure-temperature-composition measurements and x-ray data are presented for the neptunium-hydrogen system. Two hydride phases, NpH_{2+x} ($0 \leq x \leq 0.7$) and NpH_3 were found. NpH_{2+x} had a face-centered cubic structure, presumed to be of the fluorite type; NpH_3 was hexagonal, isostructural with PuH_3. The decomposition pressure of NpH_2 is given by log p(atm) = 6.257 – 6126/T(°K) (623 to 898°K). The heat of formation of NpH_2 from solid neptunium metal and hydrogen gas was $\Delta H = -28$ kcal/mole. (auth)

26340 KINETIC STUDIES ON REACTIONS OF PRASEODYMIUM OXIDES IN AN OXYGEN ATMOSPHERE: $PrO_{1.83} + O_2 \rightleftharpoons PrO_2$. B. G. Hyde, E. E. Garver, U. E. Kuntz, and L. Eyring (Iowa State Univ., Iowa City). J. Phys. Chem., 69: 1667-75(May 1965).

Rate studies were made of the following reactions: the oxidation of $PrO_{1.83}$ to PrO_2 by oxygen gas at atmospheric pressure (745 torr) in the temperature range from 235 to 314°C and the vacuum reduction of PrO_2 to $PrO_{1.83}$ in the temperature range from 242 to 347°C. The kinetics of both processes were analyzed and, with some reservations, appeared to fit the equation for a "phase-boundary-controlled" mechanism quite accurately over most of the composition range involved. This interpretation was in accord with the known properties and phase relationships of the two oxides concerned. (auth)

26341 THE POTASSIUM–IODINE, RUBIDIUM–IODINE, AND CESIUM –IODINE PHASE DIAGRAMS. Ferenc E. Rosztoczy and Daniel Cubicciotti (Stanford Research Inst., Menlo Park, Calif.). J. Phys. Chem., 69: 1687-92(May 1965).

Phase diagrams of the KI–I_2, RbI–I_2, and CsI–I_2 systems were determined by thermal analysis. These were combined

with literature data on the K–KI, Rb–RbI, and Cs–CsI systems to establish the over-all diagrams for $K-I_2$, $Rb-I_2$, and $Cs-I_2$. The systems were similar to one another in that they showed complete miscibility of liquid metal and iodine. Comparison of the freezing point depressions of the iodides and of iodine with calculated values indicated that the melts are constituted of I_2 and the ions M^+, I^-, and I_3^-. (auth)

26342 LANGMUIR STUDIES OF THE SUBLIMATION OF STRONTIUM FLUORIDE AND BARIUM FLUORIDE SINGLE CRYSTALS. Renato G. Bautista and John L. Margrave (Univ. of Wisconsin, Madison and Rice Univ., Houston, Tex.). J. Phys. Chem., 69: 1770-1(May 1965).

Langmuir sublimation studies were made, using a vacuum microbalance, on single crystal samples of SrF_2 and BaF_2. Heats of sublimation were found to be 104.8 ± 3.7 and 94.7 ± 2.2 kcal/mole for SrF_2 and BaF_2, respectively. Mass spectrometric studies yielded values of 103.7 and 92.3 kcal/mole. (M.C.G.)

26343 CATALYTIC ACTIVITY OF RARE-EARTH ELEMENT OXIDES IN HYDROGEN OXIDATION. T. T. Bakumenko (Pisarzhevskii Inst. of Physical Chemistry, Academy of Sciences, Ukrainian SSR). Kinetika i Kataliz, 6: 74-81(Jan.-Feb. 1965). (In Russian)

The catalytic activity of La, Ce, Pr, Nd, Sm, Dy, Ho, Yb, and Lu oxides in hydrogen oxidation was studied at 300 to 500°C, 550 mm Hg pressure and two type reaction mixtures (1% O_2 in H_2 and 2% H_2 in O_2). The rare earth oxides were average activity catalysts compared to the oxides of the elements from the middle of the IV period. All examined oxides had identical activity indices except for Nd and Pr oxides, which were of order higher. The heat of the activation process for the examined oxides was calculated. It was postulated that the composition of the reacting mixture and the medium affect the steady-state and catalytic activity of oxides. (R.V.J.)

26344 ON THE MECHANISM OF ADSORPTION AND ISOTOPE EXCHANGE OF CO_2 ON MgO AND $Mg(OH)_2$. O. V. Krylov, Z. A. Markova, I. I. Tretyakov, and E. A. Fokina (Inst. of Chemical Physics, Academy of Sciences, USSR). Kinetika i Kataliz, 6: 128-36(Jan.-Feb. 1965). (In Russian)

Differential isotopic methods revealed a uniform reaction of MgO surface at the activation energy and a selective reaction at the heat of adsorption. Kinetics of CO_2 and $CO^{18}O$ isotopic exchange between gaseous and adsorbed phases showed that the exchange rate increases with the temperature and with the presence of water and is not a function of CO_2 pressure. The infrared spectra revealed three different forms of CO_2 bonds with $Mg(OH)_2$ each with a different mechanism of CO_2 adsorption and exchange. Various active centers in alkali catalysts are discussed and their role in acid-base reactions is analyzed. (R.V.J.)

26345 ON THE EFFECT OF SORPTION OF OXYGEN BY A NICKEL CATALYST AND OF THE CATALYST SINTERING OF THE KINETICS OF HYDROGEN PARA-ORTHO-CONVERSION AND ISOTOPE EXCHANGE. I. P. Davydova and S. L. Kiperman (Zelinskii Inst. of Organic Chemistry, Academy of Sciences, USSR). Kinetika i Kataliz, 6: 137-43(Jan.-Feb. 1965). (In Russian)

Effects of oxygen sorption by a nickel catalyst on the kinetics of uniform hydrogen para-ortho-conversion reactions and on hydrogen isotope exchange with deuterium were studied. The observed effects showed that oxygen is well sorbed only by certain surface areas possessing high-sorptive properties while on the rest of the surface oxygen diffused deep into the catalyst surface layers. The data were in good agreement with the studies on oxygen adsorption-chemical equilibrium in the same catalyst. (R.V.J.)

26346 INVESTIGATION OF THE FORMATION, THERMAL DECOMPOSITION AND STRUCTURE OF THE SYSTEM UO_3-H_2O. Miklos Fodor, Zoltan Poko, and Elek Szabo. Magy. Kem. Folyoirat, 71: 104-10(Mar. 1965). (In Hungarian)

The system UO_3-H_2O shows different behavior depending on the quality of the oxide used as the starting material and on the conditions of preparation. Investigations were carried out to establish relationships between the properties of the starting oxides and those of their hydrolytic products. Experiments are reported on the formation and thermal decomposition of the hydrates and hydrolytic products of β-UO_3 and amorphous UO_3 obtained from ammonium uranate and from $UO_3-2\ H_2O$, respectively. Derivatographic measurements led to an accurate picture about the mechanism of decomposition, and permitted inferences concerning the structures of the compounds involved. (auth)

26347 DISSOCIATION OF SUPEREXCITED ETHYLENE PRODUCED BY ELECTRON IMPACT AND ARGON SENSITIZATION. G. G. Meisels (Union Carbide Corp., Tuxedo, N. Y.). Nature, 206: 287-8(Apr. 17, 1965).

The irradiation of argon produced reactive excited species with a yield of approximately 1.5/100 ev absorbed in argon (yields calculated on this basis are denoted as G^{Ar}) while $\eta \simeq 0.25$. These values may be combined with the isotope effect to estimate that G^{Ar} for species resulting from the reaction $(C_2H_4)^* \rightarrow (CH_2 + CH_2)$, or $(CH + CH_3)$, or $(C + CH_4)$ should be at least 0.9. However, the only products with $G^{Ar} \geq 0.15$ are hexane-1, methane, ethane, propane, hydrogen, butene-1, n-butane, and acetylene, listed in the order of increasing importance. It was concluded that homolytic dissociation of superexcited ethylene proceeds predominantly via the reactions: $(C_2H_4)^* \rightarrow (H + C_2H_3)$ or $(H_2 + C_2H_2)$. The vinyl radical produced in the first alternative may dissociate into acetylene and a second hydrogen atom. (P.C.H.)

26348 INFLUENCE OF MULLITE ON THE GRAPHITE-STEAM REACTION. D. Gearey and K. Littlewood (Univ. of Sheffield, Eng.). Nature, 206: 395-6(Apr. 24, 1965).

Nuclear graphite was reacted with steam at 1000°C after outgassing at temperatures up to 1400°C in a mullite furnace tube. The subsequent reaction rate, as measured by pressure build-up of reaction products, was found to be highly dependent on the temperature history of the sample. After outgassing at temperatures in excess of 1000°C the reaction rate at 1000°C was initially increased. However, the extent of the increase was dependent on the time and temperature of outgassing. On reaction, the rate decreased regularly with time until it leveled off to a steady value. This steady value was always larger than the rate shown before outgassing. Increasing the temperature of outgassing above about 1,250°C caused very large increases in subsequent initial and final rates. Results of other experiments in which the mullite tube was replaced by a recrystallized alumina one did not show the same perturbations. It was therefore concluded that impurity transfer from the reaction tube was responsible. (P.C.H.)

26349 PROTON EXCHANGE RATE OF ETHYLENEDIAMINE COBALT(III) COMPLEXES IN HEAVY WATER. Schoichi Hayashi (Tokyo Univ.). Nippon Kagaku Zasshi, 86: 364-5(Apr. 1965). (In Japanese)

NMR (nuclear magnetic resonance) spectrum of ethylenediamine dissolved in heavy water exhibited two sharp lines to be assigned to HDO or H_2O and CH_2 protons, which suggested rapid exchange of protons between NH_2 groups of solute and solvent. In the solutions of cobalt ethylenediamine complex salts in heavy water, signals due to HDO or H_2O, NH_2 and CH_2 protons were observed. The line widths of the latter two signals were relatively broad indicating relatively slow exchange rates of these protons. Chemical shifts of these signals were measured and the exchange rates were calculated. The values of exchange rates obtained are 6.7×10^{-2}min^{-1} for {Co en$_3$]Cl$_3$, 2.9×10^{-2}min^{-1} for trans-[Co en$_2$ Cl$_2$]F, and 9.1×10^{-3}min^{-1} for trans-[Co en Cl$_2$]Cl, respectively. (auth)

26350 ELECTRODEPOSITION OF ^{99}Tc METAL. W. D. Box (Oak Ridge National Lab., Tenn.). Nucl. Appl., 1: 155-7(Apr. 1965).

Technetium metal can be electrodeposited almost quantitatively from dilute solutions of pertechnetate ion in acidic ammonium oxalate. Films up to 18 mg/cm^2 were deposited

as dense adherent coatings on copper, gold, silver, and platinum at a current density of 1.3 amp/cm^2. (auth)

26351 ON THE SINTERING RATE OF URANIUM OXIDE POWDER UNDER OXIDIZING AND REDUCING CONDITIONS AND CONCLUSIONS ON THE FISSION GAS YIELD (RARE GAS DIFFUSION IN 16 SOLID BODIES). P. Moeller and K. Wagener (Hahn-Meitner-Institut fur Kernforschung, Berlin). Nukleonik, 7: 113-17(Mar. 1965). (In German)

When testing nuclear fuel containing uranium by post-activation-diffusion (PAD) measurements, the neutron-irradiated samples are usually annealed either in a vacuum or an inert gas atmosphere. By this treatment, measurable quantities of fission rare gases can be obtained. During this procedure, the uranium dioxide samples usually are not in equilibrium with the oxygen partial pressure. Therefore, they are oxidized or reduced, respectively, depending on the test conditions. Thermogravimetric tests and specific surface measurements on uranium dioxide powder indicate that during a change of the oxygen/uranium ratio, the sintering is markedly accelerated. This fact leads to the hypothesis that increased mobility of the lattice ions accelerates the release of the rare gas. In this way, the bursts in the rare gas release—often observed in PAD measurements can be interpreted. (auth)

26352 THERMAL MIXING BETWEEN SPIN SYSTEMS IN SOLIDS. M. Goldman (Centre d'Etudes Nucleaires, Saclay, France). Phys. Rev., 138: A1668-74(June 14, 1965).

A study is presented of thermal mixing in zero field between protons and bromine nuclei in paradibromobenzene, induced by rf irradiation at a frequency close to the bromine quadrupole resonance frequency. Experiments have been conducted at 77 and 4.2°K. This mixing leads to the cooling of the dipole-dipole interactions to a temperature which depends on the relative couplings to the lattice of the different interactions—dipolar and quadrupolar—experienced by the spin system. The ordering of the dipolar interactions is transferred to Zeeman interactions by adiabatic magnetization, which results in an enhanced proton polarization with respect to its thermal-equilibrium value. This work pays special attention to the dynamics of the evolution of the spin system during the thermal contact. This evolution proceeds from two distinct phenomena: The first is the establishment of a spin temperature in the rotating frame by rf-induced thermal mixing between dipole-dipole and quadrupole interactions. The second is a variation of this temperature at a rate and toward a steady-state limit determined by the respective spin-lattice relaxation times of the dipole-dipole and quadrupole interactions. The experiments performed at 4.2°K with paradibromobenzene verify this two-step evolution. They also demonstrate that even very low concentrations of paramagnetic impurities provide the dominant relaxation mechanism for the dipole-dipole interactions, resulting in a drastic decrease of the dynamic polarizations obtainable by this method. (auth)

26353 IMPURITY-CONTROLLED NUCLEAR RELAXATION. M. Goldman (Centre d'Etudes Nucleaires, Saclay, France). Phys. Rev., 138: A1675-81(June 14, 1965).

Proton spin-lattice relaxation-time measurements performed as a function of temperature and magnetic field on a single crystal of paradibromobenzene, at liquid-helium temperatures and at room temperature are reported. Strong evidence is displayed that at low temperature the proton spin-lattice relaxation is controlled by one kind of paramagnetic impurity. Both domains of diffusion-limited relaxation and domains of free diffusion relaxation are clearly exhibited, and the transition between these domains is consistent with a steep decrease of the spin diffusion coefficient D at a distance b_0 from the impurity, the diffusion barrier. Order-of-magnitude calculations of D and b_0 seem reasonable. The following information is derived as to the paramagnetic impurities: They probably have a Kramers degeneracy, in which case their spin-lattice relaxation in the neighborhood of 4°K is due to a Raman process. Their spin-lattice relaxation time τ at 4.2°K is comparable to 1.5×10^{-5} sec and their concentration N is of the order of 10^{-7} impurities per molecule. At room temperature, a different relaxation mechanism is effective, which is likely to originate from the dipole-dipole coupling of the protons with the bromine nuclei. (auth)

26354 ORTHORHOMBIC ELECTRON-SPIN-RESONANCE SPECTRA OF THULIUM IONS IN CaF_2. I. P. A. Forrester and S. D. McLaughlan (Royal Radar Establishment, Malvern, Worcestershire, Eng.). Phys. Rev., 138: A1682-88(June 14, 1965).

A new type of charge-compensation mechanism was found in CaF_2 from a study of the electron-spin-resonance spectrum of the thulium ion. Irradiated crystals of CaF_2 which were grown from a melt containing TmF_3 normally exhibit only a single isotropic spectrum which arises from Tm^{2+} ions in sites of cubic symmetry; but when the crystal is grown from a melt containing TM_2O_3, highly anisotropic spectra with orthorhombic symmetry are found after irradiation. These lines can be fitted to a spin hamiltonian of the form $\mathcal{H} = \beta \mathbf{H} \cdot \mathbf{g} \cdot \mathbf{S} + \mathbf{I} \cdot \mathbf{A} \cdot \mathbf{S}$, where the x, y, and z components of the g tensor lie along the mutually orthogonal directions $\langle 110 \rangle$, $\langle \bar{1}10 \rangle$, and $\langle 001 \rangle$, respectively. The constants in the hamiltonian are $g_{110} = 2.51 \pm 0.01$, $g_{\bar{1}10} = 0.36 \pm 0.01$, $g_{001} = 5.71 \pm 0.01$, $A_{110} = 1300 \pm 30$ Mc, $A_{\bar{1}10} = 1100 \pm 400$ Mc, $A_{001} = 2570 \pm 30$ Mc. Various models which might give rise to the observed spectrum are discussed. Two alternative possibilities appear to exist: The thulium ion is in the tetravalent state and is compensated by either a calcium ion vacancy or by additional F^- and/or O^{2-} ions, or the resonance arises from a Tm^{2+}-Tm^{3+} pair, with the two impurity ions occupying adjacent sites and bonded together by two substitutional O^{2-} ions. (auth)

26355 HIGH DYNAMIC POLARIZATION OF PROTONS. T. J. Schmugge and C. D. Jeffries (Univ. of California, Berkeley). Phys. Rev., 138: A1785-1801(June 14, 1965). (TID-21704)

A detailed study is presented of the dynamic polarization of the protons in the waters of hydration in the crystal (Nd, La)$_2$Mg$_3$(NO$_3$)$_{12}$ · 24H$_2$O, which occurs when one saturates a microwave forbidden transition that simultaneously flips a proton and a Nd^{3+} ion. The proton relaxation, as well as the dynamics of the polarization process, is discussed in terms of a phenomenological shell-of-influence model. A polarization apparatus is described for use at frequencies up to 75 kMc and temperatures $1.3 < T < 4.2$°K. Proton relaxation rates T_{1p}^{-1} are measured over a wide range of fields H and temperatures, and are found to be in agreement with the predicted rate $T_{1p}^{-1} \approx T_{1e}^{-1}(g_{Nd}\beta/H)^2\langle r^{-6}\rangle_{av}$, where T_{1e}^{-1} is the relaxation rate for the Nd^{3+} ion, r is the separation between proton and ion, and the average is taken over the shell of influence. At the Nd concentration studied (~1%), the local fields apparently prevent the free diffusion of spin temperature. Dynamic proton polarization measurements are made over a wide range of frequencies and temperatures: at 75 kMc and 1.5°K a polarization of at least 70% is observed. At these high polarizations, the proton magnetic-resonance line shape changes and a structure appears, due to the freezing-in of the local dipolar fields. At still higher polarizations a local-field computation predicts a series of sharp proton lines, suggesting the possibility of high-resolution nuclear magnetic resonance in solids. The crystal studied is a favorable one for construction of polarized proton targets. (auth)

26356 INFRARED-OPTICAL DOUBLE RESONANCE IN RARE-EARTH CRYSTALS. F. Varsanyi (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 14: 786-9(May 10, 1965).

Strong well-polarized absorption lines originating from an optically populated level 2000 cm^{-1} above the ground state in $Nd^{3+}(PrCl_3)$ crystals were observed at liquid helium and liquid hydrogen temperatures. The crystal, placed in the entrance focal point of a high-resolution spectrometer, was illuminated simultaneously with a tungsten lamp as the infrared source which populated the $^4I_{13/2}$ level and a monochromatic beam which served as a monitor. The first stage of the double resonance process corresponds to infrared photons of about 5μ, the second

stage is a sensitive indicator of the population in the metastable infrared level. Infrared quantum counter action at 5μ was also observed, and was compared with the infrared optical double-resonance process as an infrared detection scheme. (L.B.S.)

26357 ELECTRON SPIN RESONANCE OF DONOR CENTERS IN BERYLLIUM OXIDE. O. F. Schirmer (Institut fur Elektrowerkstoffe der Fraunhofer AG, Freiburg i. B.), K. A. Mueller, and J. Schneider. Physik Kondensierten Materie, 3: 323-34(1965).

The ESR spectra of two deep centers found in irradiated BeO crystals and powders, respectively, are reported and analyzed. They are due to electrons trapped at substitutional boron (B^{3+}) and fluorine (F^-) ions as concluded from the hyperfine interaction of the unpaired electron with the respective nuclei. The boron center revealed a static, the fluorine center a dynamic Jahn-Teller effect between 77 and 300°K. In both cases, the unpaired electron was found to be localized in nonaxial orbitals, which is shown to be consistent with the direction of the polar field of the crystal structure. The strong localization of the electron is contrasted to the behavior of donor electrons in other II–VI compounds, which are highly delocalized. (auth)

26358 THE MAGNETIC SUSCEPTIBILITIES OF ERBIUM AND HOLMIUM ETHYLSULPHATES. A. H. Cooke, R. Lazenby, and M. J. M. Leask (Oxford Univ.). Proc. Phys. Soc. (London), 85: 767-92(Apr. 1965).

The principal magnetic susceptibilities of holmium and erbium ethylsulphates were measured in the temperature range from 1.5 to 300°K. The results are compared with calculations based on crystal field parameters $A_n^m\langle r^n\rangle$ derived from the optical absorption spectra of these substances. At low temperatures, where the effects due to rare earth interactions become important, account is taken of both magnetic hyperfine, and first- and second-order magnetic dipole interactions, again using parameters derived from previous microwave resonance experiments. For both compounds, in both the principal crystallographic directions, the agreement is good, suggesting firstly that effects due to thermal expansion are surprisingly small over this wide temperature range, and secondly that rare earth electrostatic (exchange) interactions are quite negligible in these compounds at temperatures above 1°K. (auth)

26359 EFFECTS OF SOME OXIDES ON CRYSTAL MODIFICATION OF ZIRCONIA AND HAFNIA. Seijiro Nishiyama and Yuko Okamoto (Inst. of Physical and Chemical Research, Tokyo). Riki Gaku Kenkyusho Hokoku, 40: 185-9 (May 1964). (In Japanese)

The crystal modifications of ZrO_2 and HfO_2 containing BeO, MgO, CaO, SrO, BaO, Al_2O_3, or SiO_2 were studied by the x-ray powder diffraction method. When 10% of Al_2O_3 or 5% of SrO was added to ZrO_2 or HfO_2, the cubic system was obtained by heating at a relatively low temperature (500–1000°C), but not at high temperature (more than 1000°C). The low-temperature tetragonal system was not found in the phase transition of HfO_2, but was obtained by the addition of SiO_2 or SrO. The transition temperature of ZrO_2 from the low-temperature to the monoclinic system was found to be raised when BeO, BaO, or SiO_2 was added. The effect of SiO_2 was the largest among all the oxides tested. The temperature was shifted to ca 600° higher by the addition of several per cent of SiO_2, but it became constant below 1200°C when more than 10% was added. (NSA of Japan)

26360 ION-EXCHANGE DISPLACEMENT OF CESIUM FROM SOIL VERMICULITE. N. T. Coleman and F. H. Le Roux (Univ. of California, Riverside). Soil Sci., 99: 243-50 (Apr. 1965).

Exhaustive leaching of radiocesium-saturated samples of soil size separates containing vermiculite and hydrobiotite gave elution curves which suggested that Cs displacement from <20 μ fractions was governed by an exchange process. The slow removal of Cs from interlayer sites was regarded as due to very large sorption affinity rather than to small diffusion coefficients. Apparent exchange coefficients for Mg-Cs, calculated from the elution curves, were on the order of 10^4, with Cs preferred. Batch experiments with 2 to 5 or 5 to 20 μ soil material in N or 0.1 N $MgCl_2$ gave apparent exchange coefficients for Mg-Cs on the order of 10^3 when Cs was being absorbed and of 10^4 when Cs was being displaced. Potassium ions displaced radiocesium from interlayer spaces of soil vermiculite-hydrobiotite far more effectively than did Na or alkaline earth cations. Apparently, plate separation in Cs-saturated material is sufficient to admit K, thus making K-Cs exchange different from K-NH_4 or NH_4-K exchanges. Trace amounts of Cs were very slowly eluted by $MgCl_2$ from silt-size soil vermiculite-hydrobiotite. However, rates of removal were again consistent with ion exchange as being rate-controlling, with the slow removal due to very small saturation with Cs. (auth)

26361 ABSOLUTE INFRARED INTENSITIES OF HDO IN AQUEOUS SOLUTION. Charles A. Swenson (Univ. of Iowa, Iowa City). Spectrochim. Acta, 21: 987-93(May 1965).

The absolute infrared intensities of HDO were measured using either H_2O or D_2O as solvent in an attempt to gather more data on intermolecular interactions in liquid water. The intensities of the stretching vibrations were found to be much larger than the corresponding gas phase intensities as was expected for strongly hydrogen-bonded liquids. Values of dipole derivatives with respect to internal coordinates, $\partial P/\partial R$, were calculated from the experimental intensities. A prediction was made of the total intensity of the stretching vibrations of H_2O and D_2O using the $\partial P/\partial R$ and the appropriate normal coordinate transformations. (auth)

26362 KINETICS OF THE OXIDATION OF IRON(II) BY CERIUM(IV) IN AQUEOUS PERCHLORIC ACID. M. G. Adamson, F. S. Dainton, and P. Glentworth (Leeds Univ., Eng.). Trans. Faraday Soc., 61: 689-701(Apr. 1965).

A quenching method was used to study the kinetics of the oxidation of ferrous ions by ceric ions; both reactants were in the micro-molar concentration range. Over all conditions the rate can be represented by $-d[Fe(II)]/dt = k'[Ce(IV)][Fe(II)]$. At 0.3°C, k' increased with ionic strength μ and at constant ionic strength, $k' = a[H^+] + b + c/[H^+]$. As μ and the acidity were increased both the overall energy and entropy of activation decreased markedly. The reaction was catalyzed by HSO_4^- and F^- ions but not by Cl^- ions. The results may be formally interpreted in terms of oxidation of Fe(II) by $Ce(OH)^{3+}$ (k_1); $Ce(OH)_2^{2+}$ (k_2), and Ce^{4+} (k_0), with $k_0 \simeq k_2 > k_1$ at 0°C. The inequality $k_0 > k_1$ was unexpected and may indicate long-range electron transfer. The magnitude of k_1 did not fit the Marcus theory and alternative mechanisms are discussed to account for this and the marked diminution of the overall Arrhenius parameters A and E with increasing acidity. (auth)

26363 SOLID HELIUM. J. S. Dugdale (National Research Council, Ottawa). Trans. Roy. Soc. Can. (4), 2: 267-76(June 1964).

Although the zero-point energy dominates the properties of solid helium isotopes at low densities, experimental evidence is accumulating to show that, except perhaps at a few singular points or limited regions of very low density, the thermodynamic properties of the solids are very similar to those of the other inert gas solids and can probably be explained by quasi-harmonic lattice theory. (auth)

26364 COMPOUNDS OF NOBLE GASES. Zdzisław Bankowski Andrzej Cybulski, and Jerzy Gromadowski (Div. of Experimental Studies, IChO, Warsaw). Wiadomosci Chemi., 19: 95-131(Feb. 1965). (In Polish)

The chemical synthesis of noble gas compounds is reviewed and the chemical and certain physical properties are outlined for KrF_2, KrF_4, XeF_2, XeF_4, XeF_6, XeF_8, for other more complex compounds of xenon, and for compounds of radon. The particulars of the structure, thermodynamics, and spectroscopy of the noble gas compounds are discussed, and the nature of the chemical bonding is considered theoretically. The possibilities of the existence of other noble gas compounds are discussed, and a few predicted compounds are mentioned. (88 references). (TTT)

26365 COMPLEXES OF METALLOCHROMIC SUBSTANCES. VI. DETERMINATION OF FORMATION CONSTANTS AND CLASSIFICATION OF COMPLEXES BY MEANS OF THE METHOD OF PROPORTIONAL ABSORPTIVITIES. B. Budesinsky (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Z. Anal. Chem., 209: 379-84(1965).

Two simple spectrophotometric methods were developed, which are based on the estimation of one or two pairs of absorptivities in given conditions. The first extrapolation method is convenient for determination of formation constants of complexes 1:1, 2:1, and 2:2 (ligand:metal). The second calculation method is suitable for the classification of complexes 1:1 and 2:2. (auth)

26366 THERMODYNAMIC AND TRANSPORT PROPERTIES OF URANIUM DIOXIDE AND RELATED PHASES. (International Atomic Energy, Vienna (Austria)). Technical Reports Series No. 39. 1965. 110p. (STI/DOC/10/39). $2.50; S 52,50; 15/-stg; F.Fr. 10,-; DM 8,-(IAEA).

A panel meeting was held on March 16 to 20, 1964, to assess the thermodynamic and transport properties of the nonstoichiometric uranium dioxide phase. A summary of the data placed before the panel and of the conclusions reached is presented. Vibrational constants deduced from structural and heat capacity data were interrelated, thermal conductivity was correlated with electric conductivity and optical data, and entropy values were calculated by statistical treatment of simple models. A generalized theory that should allow better correlation of transport and thermodynamic properties is outlined. (D.L.C.)

Organic Chemistry

26367 PHOTOLYSIS OF ACETALDEHYDE IN THE PRESENCE OF DEUTERIUM SULFIDE. DEUTERIUM ATOM ABSTRACTION FROM DEUTERIUM SULFIDE MOLECULES BY METHYL RADICALS. Naomi Imai, Takaaki Dohmaru, and Osamu Toyama (Univ. of Osaka Prefecture). Bull. Chem. Soc. Japan, 38: 639-43(Apr. 1965).

The photolysis of acetaldehyde in the presence of deuterium sulfide was investigated over the temperature range from 200 to 300°C, in order to determine the rate constant for the deuterium atom abstraction from deuterium sulfide molecules by methyl radicals. The effect of deuterium sulfide addition was similar to that of the addition of hydrogen sulfide previously studied. The results obtained with low concentrations of deuterium sulfide can be explained by the following reaction scheme: $CH_3CHO + h\nu \rightarrow CH_3 + CHO$ (1), $CHO \rightarrow CO + H$ (2), $H + CH_3CHO \rightarrow H_2 + CH_3CO$ (3), $H + D_2S \rightarrow HD + DS$ (4), $CH_3 + CH_3CHO \rightarrow CH_4 + CH_3CO$ (5), $CH_3 + D_2S \rightarrow CH_3D + DS$ (6), $DS + CH_3CHO \rightarrow HDS + CH_3CO$ (7), $CH_3CO \rightarrow CH_3 + CO$ (8), and $CH_3 + CH_3 \rightarrow C_2H_6$ (9). The rate equation derived from the scheme, $-d[CH_3CHO]/dt = k_3k_5^{-1/2}I_a^{1/2}[CH_3CHO] + k_6k_5^{-1/2}I_a^{1/2}[D_2S]$, was in agreement with the results. The application of this rate equation led to $k_6/k_5 = 2.0 \exp(3000/RT)$, and to $k_6 = 10^{11.6} \exp(-3800/RT)$ mole^{-1} cm^3 sec^{-1}, if $k_5 = 10^{11.3} \exp(-6800/RT)$ mole^{-1} cm^3 sec^{-1}, as was reported by Ausloos and Steacie. On reinvestigating the effect of hydrogen sulfide addition, it was found that $k_4'/k_5 = 1.5 \exp(4150/RT)$, where k_4' refers to the $CH_3 + H_2S \rightarrow CH_4 + HS$ (6′) reaction. The value $k_4'/k_6 = 0.75 \exp(1150/RT)$ was thus obtained. (auth)

26368 α-HYDROGEN EXCHANGE IN THE REACTION OF 2-PHENYLETHYLDIMETHYLSULPHONIUM ION WITH BASE IN AQUEOUS SOLUTION AND OF 2-PHENYLETHYLTRIMETHYLAMMONIUM ION WITH BASE IN AQUEOUS AND ALCOHOLIC SOLUTION. S. Asperger, D. Pavlovic, L. Klasinc, D. Stefanovic, and I. Murati (Inst. "Ruder Boskovic," Zagreb and Zagreb Univ.). Croat. Chem. Acta, 36: 209-13(1964).

The α-hydrogen exchange during elimination from 2-phenylethyldimethylsulfonium bromide with OD^- in deuterium oxide was found to be almost complete under certain reaction conditions. The product, trimethylamine, from the analogous reaction of 2-phenylethyltrimethylammonium iodide with either ethoxide ion in ethanol-O-d or with OD^- in deuterium oxide was found to contain no detectable amount of deuterium above natural abundance. (auth)

26369 TRACER STUDIES OF ACID-CATALYZED REACTIONS. I. THE ISOMERIZATION OF CYCLOPROPANE OVER SILICA-ALUMINA. John G. Larson, H. R. Gerberich, and W. Keith Hall (Mellon Inst., Pittsburgh). J. Am. Chem. Soc., 87: 1880-9(May 5, 1965).

When small slugs of cyclopropane were passed over exhaustively deuterated silica-alumina catalysts, deuterium atoms were introduced into only about 10% of the product propylene molecules; the unisomerized cyclopropane was exchanged to about the same extent. Multiple deuteration was not appreciable except when D_2O was added back or when the ratio of catalyst to cyclopropane was made high. When exposed to the catalyst under identical conditions, propylene became deuterated to an extent comparable with the propylene produced by isomerization. Evidently, most of the deuterium that appears in these hydrocarbons results from an exchange process separate from the isomerization mechanism. When equimolar mixtures of cyclopropane and cyclopropane-d_6 were passed over the catalyst, both the propylene and the residual cyclopropane became extensively deuterated. It is shown that multiple deuteration of the cyclopropane occurred by a stepwise process and that the initial (low conversion) distribution of the product propylene contained approximately equimolar amounts of C_3H_6, C_3H_5D, C_3D_5H, and C_3D_6. The isomerization and isotope mixing reactions had the same activation energy. There were no first-order isotope effects. The results may be interpreted alternatively in terms of a carbonium ion mechanism, making repeated use of a small number ($\leq 10^{12}$/cm^2) of catalyst protons or cocatalytic hydroxyl groups, or as a bimolecular hydride transfer mechanism involving cyclopropyl ($C_3H_7^+$) carbonium ions. Alumina was a somewhat poorer catalyst for isomerization, but a better catalyst for exchange; silica gel was not a catalyst and did not undergo exchange with cyclopropane up to 500°C. (auth)

26370 MASS-SPECTROMETRIC STUDY OF PHOTOIONIZATION. III. METHANE AND METHANE-d_4. Vernon H. Dibeler, Morris Krauss, Robert M. Reese, and Frederic N. Harllee (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 42: 3791-6(June 1, 1965).

Photoionization-efficiency curves for the molecule and fragment ions of CH_4 and CD_4 were obtained in the wavelength region 1000 to 600 Å. The electronic structure of the molecule ion is related qualitatively to the shape of the parent-ionization-efficiency curve and the implications of the complicated vibronic behavior of the CH_4^+ ion are discussed. A qualitative explanation is given for the observed isotope effect on the parent-ionization-efficiency curve and on the fragment-ion threshold energies. Upper bounds for the ionization energies $I(CH_4) = 12.71$ and $I(CD_4) = 12.87$ ev were obtained. Other monochemical values deduced from the study are: $D(CH_3-H) = 4.41$, $D(CD_3-D) = 4.55$, $D(CH_2-H) = 4.87$, and $\Delta H_f(CH_2) = 4.07$ ev. Zero-point differences for methyl and methylene ions and neutrals were also estimated. (auth)

26371 ORGANIC COMPOUNDS OF NIOBIUM. V. REACTION OF NIOBIUM PENTAETHOXIDE WITH GLYCOLS. R. C. Mehrotra and P. N. Kapoor (Univ. of Rajasthan, Jaipur, India). J. Less-Common Metals, 8: 419-27(June 1965).

Reactions of niobium pentaethoxide with diols (ethane, 1,2- and 1,3-propane, 2,3- and 1,4-butane, and 1,5-pentane diols, hexylene glycol, and pinacol) were carried out in different stoichiometric ratios and the following three types of derivatives $(EtO)_3Nb(glycol)$, $(EtO)Nb(glycol)_2$ and $Nb(glycol)_3$ were isolated. Molecular weights of the few soluble glycollates showed that they are dimeric. (auth)

26372 DEUTERIUM ISOTOPE EFFECTS ON RATES OF METHYLENE RADICAL INSERTION INTO C-H BONDS. D. W. Placzek, D. F. Ring, and B. S. Rabinovitch (Univ. of Washington, Seattle). J. Phys. Chem., 69: 1782-6(May 1965).

Measurements were made of deuterium isotope effects on the rates of methylene insertion into C–H and C–D bonds of cyclohexane, cyclohexane-d_{12}, cyclopropane, and cyclopropane-d_6. The isotopic ratio, k_H/k_D, for methylene insertion into the C–H bonds of cyclopropane was 1.29; that for cyclohexane was 1.32. (M.C.G.)

26373 ON THE CATALYTIC ACTIVITY OF RARE-EARTH ELEMENTS IN THE CONVERSION ON n-BUTANE. Kh. M. Minachev and Yu. S. Khodakov (Zelinskii Inst. of Organic Chemistry, Academy of Sciences, USSR). Kinetika i Kataliz, 6: 89-94(Jan.-Feb. 1965). (In Russian)

Catalytic properties of La, Ce, Pr, Nd, Sm, Ho, Er, Dy, Yb, Tm, and Tb oxides in the n-butane conversion reaction at 400 to 550°C were studied using circulating flow and statistical methods. Catalytic properties of Er oxides were also studied in the propylene, ethane and ethylene conversion. Kinetics of all reactions were described by a first order equation. The specific rate constants, preexponential multipliers, and the activation energy were determined for all examined oxides. Changes in the butane magnetic properties and conversion activation energy were analyzed in the examined rare earths. (tr-auth)

26374 KINETIC PARAMETERS FOR DEHYDROGENATION AND DEHYDRATION OF ETHYL AND ISOPROPYL ALCOHOLS AND DEHYDROGENATION OF TETRALIN IN ERBIUM OXIDE. A. A. Tolstopyatova, A. A. Balandin, and Chi-chuan Yu (Zelinskii Inst. of Organic Chemistry, Academy of Sciences, Ukrainian SSR). Kinetika i Kataliz, 6: 108-14(Jan.-Feb. 1965). (In Russian)

Dehydrogenation and dehydration of ethyl and isopropyl alcohols and dehydrogenation of tetralin on erbium oxides were studied. Relative adsorption coefficients of the reaction products, true reaction activation energies, and bond energies of the C, H, and O atoms reacting with the catalyst were determined. Thermodynamic functions ΔF, ΔH, and ΔS were obtained for tetralin and isopropyl alcohol adsorption displacement by reaction products. (tr-auth)

26375 POLYMERIZATION OF CYCLIC ETHERS IN THE PRESENCE OF MALEIC ANHYDRIDE. II. BENZOYL PEROXIDE-CATALYZED POLYMERIZATION OF BCMO AND TRIOXANE IN THE LIQUID PHASE. Koichi Takakura and Koichiro Hayashi (Kurashiki Rayon Co., Ltd., Japan). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 148-54(Nov. 1964).

In view of the fact that either oxygen-γ rays or the oxygen-ultraviolet light combination is very effective for inducing polymerization of cyclic ethers in the presence of MAH, a small amount of BPO was added to the monomer mixtures. As expected, polymerization easily occurred even in vacuo at or above 50°C, exactly in the same manner as with radiation. It is well known that no polymerization of these monomers occurs by radical initiation. Part II is concerned with the results of the BPO-catalyzed polymerization of BCMO and trioxane. The investigation of the reaction mechanism will be reported in the following paper (Part III). (auth)

26376 KINETIC ISOTOPE EFFECT STUDIES OF SOME ELECTROPHILIC AROMATIC SUBSTITUTION REACTIONS. A. N. Bourns (McMaster Univ., Hamilton, Ont.). Trans. Roy. Soc. Can. (4), 2: 277-91(June 1964).

A stepwise mechanism was established for a considerable number of electrophilic aromatic substitution processes. In certain very special systems the intermediate possessed sufficient stability that actual isolation was accomplished. In others, only spectroscopic detection was possible. Usually, however, the species were short-lived that their existence as reaction intermediates could only be demonstrated by application of the variable kinetic-isotope-effect criterion of mechanism. In this category were certain diazocoupling reactions, bromodecarboxylations, iododeprotonations, and, on the basis of the work reported, bromodeprotonation, bromodesulfonation, and decarboxylation processes. For many electrophilic aromatic substitution processes a distinction between the concerted and stepwise mechanisms was not achieved. Although it is probable that for most of these an actual intermediate does intervene between reactants and products, in the absence of definite evidence for the formation of such a species in any given reaction a one-stage mechanism for that reaction cannot be excluded. The variable kinetic-isotope-effect criterion provides a definite answer only when the result is positive, since the failure to find a variation in the isotope effect can be interpreted equally well in terms of a concerted mechanism or a two-stage mechanism in which the relative rates of return of the intermediate to reactant and transformation to product do not change significantly under the conditions used in the application of the test. (auth)

Radiation Chemistry

See also BIOLOGY AND MEDICINE — Radiation Effects.

Refer also to abstract 25848.

26377 (INR-548/XVII) THE RADIATION INDUCED OXIDATION AND REDUCTION REACTIONS OF IRON IN AQUEOUS SOLUTIONS. VIII. THE DIRECT OBSERVATIONS OF REDOX PROCESSES IN THE IRRADIATED Fe–H_2SO_4–ORGANIC SUBSTANCES–H_2O–O_2 SYSTEM. THE EFFECTS OF ALDEHYDES, KETONES, GLYCOLS AND ETHERS. Roman Broszkiewicz (Institute of Nuclear Research, Warsaw (Poland)). July 1964. 12p. Dep.

The processes of the oxidation of ferrous and reduction of ferric ions in the irradiated solutions consisting of ferrous-ammon sulfate, H_2SO_4, and aldehydes, ketones, glycols, or ethers were investigated. The spectrophotometric measurements were performed directly during the irradiation. Solutions were not deoxygenated. The processes of oxidation of the ferrous ions are little affected by the structure of aldehyde or glycol, though the $G(Fe^{+3})$ values are lower in the case of ketones and diethylene glycol. Radicals formed from aldehydes, α, ω-glycols and diethyl ether reduce the ferric ions similar to those formed from alcohols. Radicals formed from ketones, α, β-glycols, glycerol, and diethylene glycol do not reduce the ferric ions. This effect is, in the case of ketones, attributed to their lack of an H-atom at the carbonyl group. Remaining radicals are supposed to be rapidly degraded. (auth)

26378 ·(NIJS-R-439) ELECTRON SPIN RESONANCE OF IRRADIATED $NaH_3(SeO_3)_2$ AND $NaD_3(SeO_3)_2$. R. Blinc, S. Poberaj, M. Schara, and J. Stepisnik (Nuklearni Institut "Jozef Stefan," Ljubljana (Yugoslavia)). Oct. 1964. 11p. Dep.(mn).

The electron spin resonance spectra of γ-irradiated $NaH_3(SeO_3)_2$ (NaHSe) and $NaD_3(SeO_3)_2$ (NaDSe) single crystals were investigated, and the principal stable damage centers could be identified as SeO_2^-. The spectra consist of a central part, due to those SeO_2^- groups which are composed of spinless isotopes of Se, and of a number of satellites due to hyperfine interaction with ^{77}Se. At room temperature, four physically nonequivalent free radicals were found in the unit cell of non-polar NaHSe and NaDSe, two of them being also chemically non-equivalent, and the complete g and hyperfine coupling tensors were determined. Significant changes occur in the spectra on cooling the samples below the corresponding ferroelectric (NaHSe) respectively antiferroelectric (NaDSe) transition points, demonstrating a doubling of non-equivalent defect sites. (auth)

26379 (NP-14813) INFLUENCE D'UN CHAMP ELECTRIQUE UNIFORME SUR LA SCINTILLATION DANS LES GAZ RARES (theses). (Influence of a Uniform Electric Field on the Scintillation of Rare Gas (thesis)). Alain Godeau (Toulouse Univ. (France). Faculte des Sciences). 1964. 70p. Dep.(mn).

Some properties of scintillators can be modified by the presence of a continuous electric field. Results obtained previously are analyzed, and the significance of these data for indicating the mechanism of light emission is discussed. The apparatus used in the experimental study is described in detail. The rare gases xenon, argon, and helium were investigated. The study confirms an amplifica-

tion phenomenon caused by the electric field and attributed to an electron process. (J.S.R.)

26380 (NYO-3329-2) RADIATION SYNTHESIS OF ARTIFICIAL KIDNEY MEMBRANES. Annual Report for the Period February 1, 1964 to January 31, 1965. (Columbia Univ., New York. Dept. of Chemical Engineering). Apr. 6, 1965. Contract AT(30-1)-3329. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The artificial kidney is a device for removing unwanted solutes of relatively low molecular weight from blood and may be used as a substitute for the natural kidney over short periods of time, as a device for removing quantities of poisonous materials from the bloodstream, or as a permanent substitute for irreversibly lost or impaired natural kidney function. The relative merits of artificial kidney membranes depend on permeability, mechanical strength, and biological compatibility. Polyvinyl alcohol membranes were investigated for use as artificial kidneys and results are reported from studies of optimum configuration and thickness for radiation-crosslinked polyvinyl alcohol. Test cells were prepared using various casting and crosslinking parameters such as radiation dose and dose rate, amount and type of polyfunctional monomer, and other factors that control the crystalline-amorphous nature and pore structure of the membrane. Results of permeability measurements made with NaCl indicate the development of a substantially improved membrane with high permeability and requisite strength. (C.H.)

26381 (RISÖ-95) SZILARD-CHALMERS PROCESSES IN AMMONIUM DI-HYDROGEN PHOSPHATE AS STUDIED BY ELECTROPHORESIS AND ELECTRON SPIN RESONANCE TECHNIQUES. J. Fenger (Atomenergikommissionen, Risø (Denmark). Forsoegsinstitut). Dec. 1964. 88p. Dep.(mn)

In an attempt to identify and characterize hot-atom induced defects by electron spin resonance (esr), a comparative study of hot-atom reactions in single crystals of ammonium di-hydrogen phosphate (ADP) by means of electrophoresis and esr techniques was undertaken. Single crystals of ADP, in some cases fully or partly deuterated, in others moreover enriched in ^{15}N, were irradiated with neutrons in the thermal column of DR2 at temperatures between -196°C and 30-40°C and were subsequently thermally annealed at temperatures between -78 and 150°C prior to analysis. The effects of γ irradiation of the crystals before or after the neutron irradiation were also investigated. In electrophoresis only the chemical fate of the β-active ^{32}P was studied. In accordance with previous work it was demonstrated that dissolution of the irradiated crystals led to distribution of the ^{32}P activity on at least nine identified phosphorus oxy-anions. Variation of the irradiation temperature between -196 and 0°C only affected the state of oxidation of ^{32}P, which suggests that the P-O-P and P-P bonds in the skeleton of complex phosphorus oxy-anions are formed in hot reactions. Almost all ^{31}P in ^{32}P-labeled anions appeared to be in the highest possible oxidation state. The ^{32}P-activity distribution was found to be dependent upon the H/D fraction in deuterated crystals, mainly in the retention, which was increased approx. 50% by complete deuteration. Mixed crystals had a larger content of ^{32}P in oxidized states. γ irradiation had an overall oxidizing effect on ^{31}P and triggered the formation of P-P bonds. ESR spectra of neutron-irradiated single crystals of $NH_4H_2PO_4$, $ND_4D_2PO_4$, and $^{15}ND_4D_2PO_4$ demonstrated the formation of PO_3^{-2} radicals, most of which are presumably due to oxygen displacements by ^{14}C recoils from the $^{14}N(n,p)^{14}C$ process. The PO_3^{-2} radical was considerably more stable in deuterated than in ordinary ADP. In addition, several line systems of unknown compounds were observed; in $ND_4D_2PO_4$ they were reduced for certain orientations of the crystals to doublets, which suggests a hyperfine coupling to ^{31}P. (P.C.H.)

26382 (RPI-321-1) [PROGRESS REPORT ON RADIATION CHEMISTRY, OCTOBER 1, 1963-SEPTEMBER 30, 1964]. S. Dondes (Rensselaer Polytechnic Inst., Troy, N. Y. Mason Lab.). Jan. 29, 1965. Contract AT(30-3)-321. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The ion mechanisms and transient species of alpha-irradiated N and N-O mixtures were studied by examination of the luminescent spectra produced. Spectra from ozone radiolysis are also being investigated. A study of N fixation chemistry was continued. In another study, radioinduced production of NO_2 in N_2-O_2 mixtures was investigated. An experiment is also reported in which a value for production of $^{14}N-^{15}N$ under ionizing radiation was G_N = 11.5 when the O_2 concentration was less than 0.015%. Results of other experiments showed that rare gases have little effect on radioinduced production of N atoms. Investigations of 25-Mev electron irradiation of CO to produce C_2O_3 are described in which gram quantities were obtained. Photolytic production of C_2O_3 from CO is also being investigated. Mechanisms and kinetics of chemical reactions are being studied by mass spectrometry. An investigation of S oxidation using glow-discharge O_2 is described. A similar study of N reactions with S and S compounds is also described along with those of N with organic compounds. Results obtained using glass fibered U in the Brookhaven reactor loop include data on N fixation, dosimetry, NO_2 formation, and changes in NO_2/N_2O ratio during operation. Studies were initiated on contamination that exists when gases and liquids are irradiated with fission fragments. Experiments in which in-reactor fission fragments are used to produce light in quartz-confined gases are reported. Observations using quartz light pipes showed that the spectra were continua in all cases. (J.R.D.)

26383 THE IONIZATION AND DISSOCIATION OF METHYL BUTYL KETONES UNDER ELECTRON IMPACT. I. METHYL n-BUTYL KETONE AND METHYL ISOBUTYL KETONE. Motoyoshi Hatada and Kozo Hirota (Japanese Associations for Radiation Research on Polymers, Neyagawa, Osaka and Osaka Univ.). Bull. Chem. Soc. Japan, 38: 599-601(Apr. 1965).

Calculations were made in an attempt to predict ionization potentials and bond scission probabilities of methyl butyl ketones under electron bombardment by assuming a wave function for each bond between the groups of the molecules. The results of the calculations were compared with those obtained from the mass spectra. Data are presented in tables and graphs. (M.C.G.)

26384 A MÖSSBAUER RESONANCE ABSORPTION STUDY OF THE PHOTOLYSIS AND RADIOLYSIS OF FERRIC OXALATE. Nobufusa Saito, Hirotoshi Sano, Takeshi Tominaga, and Fumitoshi Ambe (Tokyo Univ. and Ochanomizu Univ., Tokyo). Bull. Chem. Soc. Japan, 38: 681-2(Apr. 1965).

The Mössbauer resonance absorption technique was used to study the radiolysis and photolysis of ferric oxalate. ^{60}Co gamma rays were used in the radiolysis and light from a mercury lamp in photolysis. The Mössbauer spectrum of ferric oxalate consists of two lines, at 0.27 and 0.70 mm/sec (vs stainless steel). After irradiation with gamma rays the height of both lines decreased and new lines appeared at about 0.5 and 2.3 mm/sec. The positions of these lines almost corresponded to those in the spectrum of non-irradiated ferrous oxalate. The Mössbauer spectrum of ferric oxalate that had undergone photolysis was almost identical to that of the gamma-irradiated sample. (M.C.G.)

26385 SOME PHYSICAL AND CHEMICAL PROCESSES IN AIR CAUSED BY IONIZING RADIATION. M. T. Dmitriev (Scientific Research Inst. of Hydrometeorological Instrumentation, USSR). Fiz. Atm. i Okeana, 1: 302-12 (Mar. 1965). (In Russian)

Some physical and chemical processes in air such as ionization, molecule dissociation, and production of ozone, nitrogen oxides, and carbon dioxide caused by ionizing radiation were analyzed. The data obtained can be used to evaluate the efficiency of different ionizing radiations in the atmosphere. (auth)

26386 IRRADIATION-INDUCED CHANGES IN THE ELECTRIC CONDUCTIVITY OF ALKALI HALIDE CRYSTALS DOPED WITH DIVALENT CATIONS. E. K. Zavadovskaya, M. I. Ignat'eva, and I. Ya. Melik-Gaikazyan

(Tomsk Polytechnic Inst., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 68-70(Jan. 1965). (In Russian)

The electric conductivities of NaCl, KCl, and KBr crystals doped with Mn, Cd, Sr, or Pb were measured at 20 to 200°C before and after irradiation with x rays (10^4 r at the rate of 30 r/min). The measurements were undertaken to investigate the mechanism of radiation suppression of ionic conductivity in alkali halide crystals. Doping with Mn or Cd had no effect on the sensitivity to irradiation of the NaCl conductivity. Doping with Pb enhanced the influence of irradiation on the conductivity of KCl and KBr, and doping with Sr decreased the influence of irradiation on the conductivity of KCl crystals. It is concluded that divalent dopants that neither increase the ionic conductivity nor participate in the trapping of holes do not alter the effect of irradiation on conductivity; dopants that increase the concentration of isolated cation vacancies and interact with electrons enhance the suppression of conductivity by irradiation; and dopants that produce additional hole traps reduce the effect of irradiation on conductivity. (ATD)

26387 EFFECT OF PROTON BOMBARDMENT ON THE CONDUCTIVITY OF ALKALI HALIDE CRYSTALS. V. A. Chernyshev. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 71-4(Jan. 1965). (In Russian)

The conductivities of KCl, KBr, and KI crystals were measured at 20 to 140°C before and after bombardment with 6×10^{14} or 9×10^{14} 4.3-Mev protons per ^{2}cm. In all cases the relation between the logarithm of the conductivity of the bombarded crystal and the reciprocal of the absolute temperature was not linear, the bombarded material having a lower apparent activation energy than the initial material at low temperatures and a higher activation energy at high temperatures. The ratio of the conductivity before bombardment to that after bombardment was less than unity at the lowest temperatures, reached a maximum (as great as 20 in the case of heavily bombarded KCl), and subsequently decreased but remained greater than unity. For KCl and KI this ratio was less than unity only very near the low end of the temperature range, but for KBr it reached unity only at about 70°C and the maximum was very low (about 1.05). The temperature at which this ratio reached its maximum shifted toward lower values with increasing proton bombardment and toward higher values in going from KCl through KBr and KI. Possible reasons for this behavior are discussed briefly. (ATD)

26388 ELECTRIC AND THERMAL CONDUCTIVITIES AND OPTICAL ABSORPTION OF IRRADIATED ALKALI HALIDE CRYSTALS. L. F. Vorozheikina, D. D. Igitkhanishvili, N. G. Politov, and V. G. Kvachadze (Inst. of Physics, Academy of Sciences, Georgia SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 75-7(Jan. 1965). (In Russian)

The electric conductivity at 75 to 250°C and the maximum absorption coefficient in the F band of KCl crystals were measured before and after slow neutron irradiation with doses to 2.4×10^{16} nvt. The conductivity at 135°C first decreased with increasing dose, then increased to a maximum at 12×10^{15} nvt, and subsequently decreased. The absorption coefficient showed inverse behavior: a maximum at a moderately small dose and a minimum at 12×10^{15} nvt. The crystals investigated were of two kinds, with pre-irradiation conduction activation energies of 1.0 and 1.18 ev. The activation energy was not changed by irradiation except when the dose was near the critical value producing a large change in conductivity. Crystals subjected to the critical dose showed two activation energies, both smaller than that of the virgin material. The smaller of these activation energies was effective at temperatures below 135°C, and the larger at temperatures higher than this. The higher conductivities of crystals given the critical dose are ascribed to the appearance of new current carriers, and it is suggested that these are decay products of dislocations. The thermal conductivity, optical absorption coefficient at 300 mμ, and relative dislocation density of LiF were measured as functions of neutron dose. A close correlation was found between the heat conductivity and the number of defects produced by the irradiation. (ATD)

26389 INFLUENCE OF PRE-IRRADIATION BY GAMMA-RAYS AND HEATING ON THE ACTIVITY OF THE CATALYST $Ag/Ag_2C_2O_4$. V. V. Sviridov, G. A. Branitskii, and L. V. Potanina. Izv. Vysshykh Uchebn. Zavedenii, Khim. i Khim. Tekhnol., 7: 577-82(1964). (In Russian)

Irradiation with γ rays (2.4×10^5 r) of the catalyst $Ag/Ag_2C_2O_4$, obtained by the partial tribochemical decomposition of silver oxalate, showed little effect on its activity in the decomposition of hydrogen peroxide. The initial heating of the catalyst at 40 and 80°C caused an increase of the catalytic activity, especially significant at 80°C. Exposure, preceding heating, decreased the effectiveness of heating at 40°C. Smaller doses (2×10^3 r) caused the same results if the heating was at 80°C. Considerably greater doses in these conditions led to significant intensification of the heating effectiveness. (tr-auth)

26390 THE RADIATION CHEMISTRY OF BENZYL ACETATE AT −196 AND 20° IN POLAR SOLVENTS. James A. Ward and William H. Hamill (Univ. of Notre Dame, Ind.). J. Am. Chem. Soc., 87: 1853-7(May 5, 1965).

The γ radiolysis of benzyl acetate at ≥2 mole % in ethanol gave $G(CH_3CO_2H) = 4.6$ at 20°C and 2.5 at −196°C. In methyltetrahydrofuran the corresponding yields were 2.9 and 1.9. Yields of benzyl radical at −196°C were equivalent to acid. Comparable yields of acid were obtained at ~2% benzyl acetate in acetone and in acetonitrile at 20°C. In all these solutions CO_2 was a minor product. In hydrocarbon solvents, CO_2 was a major product and no acid was produced. The results are consistent with dissociative electron attachment as a primary process to give benzyl radical and acetate ion. In polar media combination of the acetate ion with the protonated solvent, via the molecular cation, accounted for acetic acid by proton transfer. In nonpolar media it appeared that charge recombination proceeds by field emission from acetate ion, followed by prompt decomposition of the acetoxy radical. (auth)

26391 ELECTRON PARAMAGNETIC RESONANCE STUDY OF RADICALS PRODUCED IN IRRADIATED AMIDES. Max T. Rogers, Sara-Jo Bolte, and P. S. Rao (Michigan State Univ., East Lansing). J. Am. Chem. Soc., 87: 1875-9(May 5, 1965).

An electron paramagnetic resonance (EPR) study of the radicals produced by electron irradiation of a series of polycrystalline amides, N-alkylamides, and N,N-dialkylamides at low temperatures was made. The isotropic hyperfine interactions with the protons usually permitted identification of the radical species. For the N-alkyl- and N,N-dialkylamides the radiation damage consisted of loss of a proton from the carbon atom of the alkyl group adjacent to nitrogen. In the amides and carboxylic acids a proton was lost from the carbon atom adjacent to the carbonyl group. When there were no hydrogen atoms on the carbons adjacent to nitrogen or carbonyl, other bonds could be broken. Thus, trimethylacetic acid and trimethylacetamide gave the t-butyl radical. The hyperfine splitting constants tended to be lower when the radical site was adjacent to nitrogen, presumably as a result of some delocalization of the odd electron onto nitrogen. (auth)

26392 ENERGY MIGRATION AND LOCALIZATION PROCESSES IN γ-IRRADIATED, AMORPHOUS n-ALKYL DISULFIDES. Frank K. Truby, Duane C. Wallace, and James E. Hesse (Sandia Lab., Albuquerque, N. Mex.). J. Chem. Phys., 42: 3845-51(June 1, 1965).

It was previously determined that amorphous alkyl disulfides irradiated at 77°K contain ionic species, alkyl radical species, and RS· radical species. A study was undertaken to determine the relative amounts of these species as a function of alkyl chain length in an effort to understand more clearly the energy migration and localization processes that occur in these compounds. It was found that no significant dependence of alkyl chain length (from methyl disulfide through eicosyl disulfide) occurs for the yield of ion pairs formed as a result of charge migration to the sulfur. Results indicated that essentially all free charge created in these compounds as a result of exposure to ionizing radiation migrates to and localizes at

the disulfide group. From examination of the alkyl and RS· radical yields in these compounds as a function of chain length, it appeared that excitation also localizes at the disulfide group. However, localization of excitation at the sulfur group occurred less readily than did charge localization. Models concerning possible mechanisms for localization of excitation are discussed. Utilizing the models presented, the results of this study indicated that the probability for localization of excitation at the disulfide group is about seven times greater than that for localization of excitation at any CH_2 group. (auth)

26393 LIMITS ON THE LIFETIME OF NONEQUILIBRIUM Fe^{3+} IONS IN SOME IONIC SOLIDS FROM THE MÖSSBAUER EFFECT. G. K. Wertheim and H. J. Guggenheim (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 42: 3873-8(June 1, 1965).

The lifetime of higher valence states produced by the Auger effect could be obtained from the Mössbauer effect in the case of some favorable isotopes. It is shown that valence states higher than Fe^{2+}, which are produced following the electron capture decay of divalent ^{57}Co in ZnF_2 have lifetimes less than 10^{-8} sec. A similar limit was obtained for the lifetimes of higher charge states of iron produced by divalent cobalt diffused into NaF with the aid of charge-compensating sodium vacancies. Trivalent iron had lifetimes greater than 3×10^{-8} sec in NaF, if charge compensation was accomplished by oxygen. The lifetime in hydrated ferrous ammonium sulfate was 5×10^{-8} sec. The short lifetimes even of Fe^{3+} in some divalent lattices indicated that the lifetimes of higher valences will generally be too short to be observed with the present technique. It also suggested that valence states that do not occur in stable compounds will generally have short lifetimes and be difficult to detect. (auth)

26394 PHOTOINDUCED CHANGE OF ORGANIC FREE RADICALS AS STUDIED BY ESR. V. CONVERSION OF CYCLOHEXANOL-1 TO CYCLOHEXANOL-2 RADICALS IN IRRADIATED CYCLOHEXANOL. Tadayuki Ohmae, Shunichi Ohnishi, Hiroshi Sakurai, and Isamu Nitta (Osaka Univ.). J. Chem. Phys., 42: 4053-4(June 1, 1965).

The photochemical response of cyclohexanol-1 radicals produced by irradiation of cyclohexanol was studied. The cyclohexanol samples were evacuated and sealed in quartz tubes at −196°C. Irradiation was performed with 1.5-Mev electrons from a Van de Graaff accelerator (total dose 10 Mrad), with the sample tubes held just under the surface of liquid nitrogen. ESR spectra were recorded at various temperatures. Ultraviolet illumination was carried out at −196°C. This gradually changed the initial nine-line spectrum (triple-triplet) to a six-line one. The total concentration of radicals, however, remained constant. Warming reversed this process to a certain extent. (M.C.G.)

26395 COLLISION-INDUCED LUMINESCENCE OF GASES. L. W. Sieck (Aerospace Research Labs., Wright-Patterson AFB, Ohio) and J. A. Llewellyn. J. Chem. Phys., 42: 4300-1(June 15, 1965).

The luminescence of argon induced by 3-Mev electrons is described. Argon and krypton containing around 3% nitrogen were also studied. The spectral bands are discussed. (M.C.G.)

26396 ELECTRON SPIN RESONANCE STUDIES OF γ-IRRADIATED SINGLE CRYSTALS OF AROMATIC COMPOUNDS. PART I. DIPHENYLMETHANE. N. M. Atherton and R. S. F. Harding (Sheffield Univ., Eng.). J. Chem. Soc., Suppl. 1, 5587-91(1964).

The electron spin resonance spectra of γ-irradiated single crystals of diphenylmethane showed a proton hyperfine doublet, which is believed to arise from the α-protons in diphenylmethyl radicals. The coupling tensor is discussed in relation to the electronic structure and conformation of the radicals and their orientation in the crystal. (auth)

26397 EFFECT OF SOME CHEMICALLY INERT SALTS ON THE RADIOLYSIS OF WATER. Jean Rozenberg and Lucien Dolle (CEN, Saclay, France). J. Chim. Phys., 62: 217-18(Feb. 1965). (In French)

The initial yields following reactor irradiation for the formation of decomposition products of water sealed in ampules together with salts of chemically inert elements. A study of the variation of the yield of molecular hydrogen as a function of the concentration of cadmium nitrate showed that the cadmium salt leads to a reduction in the H_2 yield. This reduction was attributed to the solvated electron at the level of the cluster. A decrease of the H_2 yield was also observed for the ions (in decreasing effect) $Gd^{3+} > Mg^{2+} > Cd^{2+} > Zn^{2+}$. (J.S.R.)

26398 RADIOLYTIC REDUCTION OF POTASSIUM MANGANATE IN ALKALINE SOLUTION. M. Haissinsky and J.-C. Petit (Laboratoire Curie, Paris). J. Chim. Phys., 62: 222-3(Feb. 1965). (In French)

The reduction yields of K_2MnO_4 in 0.2 and 1 N NaOH solution, both aerated and degassed, after radiolysis by γ rays were determined. The results showed that the initial reduction yield is the same in the presence and absence of air, and has the mean value $G(-MnO_4^{2-}) = G(MnO_2) = 0.9 \pm 0.1$ for sufficiently concentrated solutions. For 1 N NaOH $G(-MnO_4^{2-}) = 0.70$. Degassed solutions were also irradiated and the MnO_2, H_2, and O_2 products formed were determined, and the yields were $G(-MnO_4^{2-}) = 0.70$, $G(O_2) = 0.50$, and $G(H_2) = 0.25$. These results are discussed. (J.S.R.)

26399 RADICAL AND MOLECULAR YIELDS IN THE γ RADIOLYSIS OF ALKALINE SOLUTIONS. M. Haissinsky (Laboratoire Curie, Paris). J. Chim. Phys., 62: 224-5 (Feb. 1965). (In French)

The γ radiolysis of various redox systems in alkaline media was undertaken in order to resolve the contradictory results obtained previously. The results obtained for the radiolytic oxidation of alkaline phosphites showed that at pH 10.9 to 11.8 the phosphites are oxidized into phosphates. Neither O_2 nor HO_2^- was detected. There was a marked deficit in hydrated electrons. The origin of this deficit is discussed and it is suggested that in redox systems the molecular and radical yields are difficult to determine correctly. (J.S.R.)

26400 THE EFFECT OF CUPRIC ION ON THE RADIATION CHEMISTRY OF AQUEOUS GLYCINE. Rodney L. S. Willix and Warren M. Garrison (Univ. of California, Berkeley). J. Phys. Chem., 69: 1579-83(May 1965). (UCRL-11728)

A study was made of the effects of cupric ion on the radiation chemistry of oxygen-free glycine solutions over the pH range 3.0 to 9.0. At pH < 6, the hydrated electron e^-_{aq}, derived from water, was removed by Cu^{2+} through simple capture; the hydroxyl radical was scavenged by glycine to give the NH_2CHCO_2H radical. The over-all reaction stoichiometry is given by: $2Cu^{2+} + NH_2CH_2CO_2H + H_2O \rightarrow 2Cu^+ + NH_3 + CHOCO_2H + 2H^+$. At pH > 6 an additional reaction occurred with the stoichiometry: $NH_2CH_2CO_2H + H_2O \rightarrow NH_3 + CH_3OH + CO_2$. The latter process was associated with capture of e^-_{aq} by the bis(glycinato)copper(II) chelate. A detailed reaction scheme for the formation of the observed products over the pH range 3.0 to 9.0 is described. (auth)

26401 IONS PRODUCED BY ELECTRON IMPACT WITH THE DIMETALLIC CARBONYLS OF COBALT AND MANGANESE. Robert E. Winters and Robert W. Kiser (Kansas State Univ., Manhattan). J. Phys. Chem., 69: 1618-22(May 1965).

A mass spectrometric study of dimanganese decacarbonyl and dicobalt octacarbonyl revealed that the M_2^+ ion is a major positive ion formed in electron-impact-induced fragmentation. Carbon monoxide molecules were apparently lost from the parent molecular ions in successive fissions. Ionization and appearance potentials are presented for the principal positive ions formed from the two compounds studied. Assignments of the probable processes of ionization and dissociation were made, consistent with the observed energies. Ionization potentials of $8.1_2 \pm 0.2_2$, and $8.5_8 \pm 0.1_0$ ev were found for $Co_2(CO)_8$ and $Mn_2(CO)_{10}$, respectively. A value of 3.3 ev was derived for $D[(CO)_4Co-Co(CO)_4]$. Negative ions produced under electron impact were also observed. (auth)

26402 THE VAPOR PHASE RADIOLYSIS OF ETHANOL. L. W. Sieck and R. H. Johnsen (Florida State Univ., Tallahassee). J. Phys. Chem., 69: 1699-1703(May 1965). (TID-21417)

Initial and nonscavengable yields from the radiolysis of ethanol vapor at ~45 mm (25°C) were measured. The contribution made by ionic species to the reaction products is discussed. (auth)

26403 ELECTRON IRRADIATION OF HYDROCARBONS. II. MODEL SYSTEM FOR RADICAL REACTIONS AND DIFFUSION IN RADIOLYSIS. P. Claes and S. Rzad (Université, Louvain, Belg.). J. Phys. Chem., 69: 1780-2 (May 1965).

Magee's theory of the expansion of a track formed by an ionizing particle was applied to reactions of radicals and diffusion in radiolysis. Radiolysis of hydrocarbons in pure solvent by electron irradiation was considered. The disappearance of organic radicals and of hydrogen atoms in a single track is discussed and calculated curves are presented. (M.C.G.)

26404 RADIOLYSIS OF $N^{15}N^{14}O$. R. Gorden, Jr., and P. Ausloos. J. Res. Natl. Bur. Std., 69A: 79-85(Mar.-Apr. 1965).

The gas-phase gamma radiolysis of $^{15}N^{14}NO$ was investigated as a function of dose concentration, and temperature (-80 to 376°C). Around 40°C the ratios $^{30}N_2/^{29}N_2$ and $^{15}NO/^{14}NO$ were 0.1 and 0.4, respectively, independent of dose and concentration. In the radiolysis of $^{14}N^{14}NO$-^{15}NO mixtures it was found that the ion pair yield of ^{14}N was 0.5. The ion pair yield of $^{29}N_2$ in the radiolysis of $^{15}N^{14}NO$ increased with temperature from 2.6 at 50°C to 21.7 at 376°C. On the other hand, the yield of $^{30}N_2$ was, within experimental error, not affected by a change in temperature, indicating that only the "molecular" nitrogen increases with an increase in temperature. The occurrence of dissociative electron attachment processes was consistent with the experimental observations. The yields of $^{29}N_2$ and $^{30}N_2$ increased when a potential difference was applied during radiolysis at the saturation plateau. The latter increase can be accounted for by an enhancement of neutral excited molecule decompositions. Addition of xenon and krypton enhanced the decomposition of nitrous oxide. The results indicated that N atoms play a relatively less important role in the inert gas-induced decomposition than in the direct radiolysis. (auth)

26405 STUDIES ON CREEP OF POLYETHYLENE. (ESPECIALLY, ON THE EFFECTS OF γ-RAY IRRADIATION). Jobu Awatani and Matsuo Minegaki (Osaka Univ.). J. Soc. Mater. Sci. Japan, 14: 205-11(Mar. 1965). (In Japanese)

The creep properties of high-density polyethylene were determined using a test machine specially designed to work under the constant stress conditions. The tests were carried out at constant temperatures from 20 to 90°C at several stress levels. The instantaneous strains occurring just after the weighting were evaluated on the basis of applied stress and Young's moduli measured by the vibrating reed method. The creep curves exclusive of ultimate stage to failure, generally consisted of two stages, both expressed by Nutting's equation. The first stage could be approximately expressed by Andrade's equation, but the period of this stage became shorter with increasing temperature and was hardly measurable at temperatures above about 80°C. For the second stage, the creep strain ϵ_{c2} could be denoted by the equation, $\epsilon_{c2} = a_{20}\sinh(\alpha\sigma)\, t^{n_2}$, similar to Findley's equation, as a function of stress σ and time t. The a_{20}, α, and n_2 are material constants dependent on the temperature. In the range of the test temperature, a_{20} decreased, α increased, and n_2 slightly decreased with increasing temperature. Creep tests were also made with the samples irradiated with gamma radiation from ^{60}Co (dose rate, 10^5r/hr). The creep character depended markedly on both the radiation dose and the atmosphere of irradiation. The samples irradiated in a vacuum showed higher creep resistance, and the creep strain decreased with increasing crosslinking as $\epsilon_r = \epsilon_0 e^{-\alpha x}$, where ϵ_r is the creep strain of the irradiated sample, ϵ_0 the creep strain of the nonirradiated sample, x the degree of crosslinking, and α a constant independent of stress and temperature. On the other hand, irradiation in air did not change the creep properties uniformly. These phenomena are explained by two inverse effects of radiation, crosslinking and the degradation, in which the former increases with increasing dose and raises the creep resistance, but the later occurs predominantly in the surface layer when the thinner sample is irradiated at a low dose rate, and decreases the creep resistance. (auth)

26406 QUENCHING EFFECTS OF SEVERAL COMPOUNDS IN NAPHTHALENE SCINTILLATORS. Shigeo Kobayashi and Sohachiro Hayakawa (Tokyo Inst. of Tech.). Japan J. Appl. Phys., 4: 181-9(Mar. 1965).

Fluorescence quenching of solution scintillators with molten naphthalene as a solvent is studied with excitation by gamma rays and uv light. The material used as fluorescent solutes are anthracene, PPO, BBO, POPOP, QP, DPH and DPS. The quenchers used are carbon tetrachloride, phenyl halides, and organic compounds of lead and boron. The experimental results are analyzed according to the Stern-Volmer equation. The rates of quenching by carbon tetrachloride and iodobenzene are comparable to those of energy transfer as given on usual liquid scintillators. The effects of phenyl halides except iodobenzene are quite slight. The rates of quenching are higher by 20 to 60% under excitation by gamma rays than by 254 mμ light. Other results obtained for both modes of excitation show that addition of a lead compound tends to increase the sensitivity of the scintillators to gamma rays. (auth)

26407 "STEPWISE" RECOMBINATION OF RADICALS IN IRRADIATED ORGANIC COMPOUNDS. II. ON THE FORMAL-KINETIC MODEL AND A METHOD FOR EVALUATION OF KINETIC CONSTANTS. A. I. Mikhailov, Ya. S. Lebedev, and N. Ya. Buben (Inst. of Chemical Physics, Academy of Sciences, USSR). Kinetika i Kataliz, 6: 48-55 (Jan.-Feb. 1965). (In Russian)

Studies were made of various models of free-radical recombination in solids (when at a fixed temperature a part of the free radicals are destroyed while the rest remain). The results of formal kinetic calculations were correlated with experimental data. Experiments were carried out on naphthalene, cyclohexane, acetic acid, and phenol. At doses <0.125 MR/sec the hypothesis of uniform radical distribution was confirmed; at smaller doses, considerable recombination was evident. Thus, the experiments suggest a model of radical group (pair) localization, which was confirmed in all cases except cyclohexane. (R.V.J.)

26408 THE CATALYTIC ACTIVITY OF γ-IRRADIATED SILICA GEL IN HOMOMOLECULAR OXYGEN EXCHANGE. Yu. A. Mishchenko, G. K. Boreskov, and V. I. Gorgoraki (Karpov Inst. of Physics and Chemistry, USSR). Kinetika i Kataliz, 6: 179-80(Jan.-Feb. 1965). (In Russian)

Effects of γ radiation on the catalytic activity of silica gel in isotopic exchange of molecular oxygen were studied using various impurity silica gels treated at 600°C and 10^{-5} mm Hg pressure for 24 hr prior to irradiation with ^{60}Co γ rays at 100 R/sec in a vacuum at liquid nitrogen temperature. Following irradiation to $\sim 7 \times 10^6$ R the specimens showed a considerable activity in relation to homomolecular reaction. At a room temperature the reaction proceeded very rapidly until it reached a certain conversion (depending on the total surface and radiation dose); then it stopped. The results indicated that γ-induced active centers are the principal factors in homomolecular oxygen exchange. Free radicals of the $-\overset{|}{\underset{|}{Si}}-$ or $-\overset{|}{\underset{|}{Si}}-O$ type formed in γ irradiation silane groups. (R.V.J.)

26409 RADIATION-INDUCED POLYMERIZATION OF OCTENE-1. Yoneho Tabata and Takayoshi Ando (Japan Atomic Energy Research Inst., Tokyo). Kobunshi Kagaku, 22: 103-6(Feb. 1965). (In Japanese)

Radioinduced polymerization of octene-1 was carried

out in the temperature range of −196 to +50°C in both the liquid and solid states of the monomer. The following variables were studied: dependence of polymerization rate on temperature; effects of radical scavengers on the polymerization at various temperatures; dose rate dependencies of the polymerization rate at −78 and +20°C; and effects of various solvents on the polymerization. Although the Arrhenius plot of the polymerization rate did not yield a linear relation, the total polymerization rate was separated into radical and ionic contributions. The rate of polymerization was proportional to the first power of the dose rate at +20 and −78°C. At relatively high temperatures, the rate of polymerization was accelerated by carbon tetrachloride, while the rate was retarded by benzene. On the other hand, at low temperature, the rate of polymerization was not affected by carbon tetrachloride, while the rate was accelerated by benzene. From these experimental results, it was concluded that a cationic polymerization is operative at low temperatures whereas a radical mechanism predominates at higher temperatures. (auth)

26410 RADIO-CHEMICAL GRAFT-COPOLYMERIZATION OF STYROL ON POLYETHYLENE ACCORDING TO THE VAPOR-PHASE METHOD. H. Beine, E. Foege, A. E. Schwind, and E. Zilinski. Monatsber. Deut. Akad. Wiss. Berlin, 6: 871-2(1964). (In German)

Some results are reported on the grafting of pre-irradiated, high-pressure polyethylene foils in styrol vapor at room temperature. The rate of grafting was measured as function of radiation dose and grafting time. In the latter case, the grafting rate first increases linearly with time rather rapidly, then reaches a maximum at about 400 minutes and further decreases slightly to a limiting value. This limiting grafting rate and the time at which it is reached both depend on the radiation dose. (CFSTI)

26411 ELECTRON SPIN RESONANCE OF IRRADIATED METHACRYLIC ACID. Yoshiro Sakai (Government Industrial Research Inst., Nagoya, Japan) and C. H. Bamford. Nagoya Kogyo Gijutsu Shikensho Hokoku, 13: 444-7(Dec. 1964). (In Japanese)

Electron spin resonance absorption was studied with methacrylic acid irradiated by ultraviolet light in the solid state at temperatures ranging from +10° to −40°C. The radical concentrations became maximum at −5°C. At −5°C there may be a transition in the crystal, enhancing the mobility of the molecule and radical formation at this temperature. Irradiation at temperatures above −5°C yielded radicals that gave the well-known "methacrylate" spectrum consisting of nine lines (a quintet with a weaker quartet) having an equal spacing of 11.6 gauss. Below this temperature each of the four weak lines were split into two with the formation of a 13-line spectrum. When the irradiation time was constant the splitting became more noticeable as the temperature of irradiation was lowered to about −30°C. The results can be understood in terms of the conformation. The non-equivalence of the two methylene hydrogen atom is assumed, and by calculation using Symons's relation, it is found that the whole methylene group rotated about the C-C bond by 5° from the symmetrical conformation, but there is no distortion of the $H^{(1)}CH^{(2)}$ angle. (auth)

26412 GAMMA-RAY INDUCED GRAFT COPOLYMERIZATION. X. EFFECT OF SOLVENT ON GRAFT COPOLYMERIZATION OF STYRENE ON CELLULOSE ACETATE BY PRE-IRRADIATION TECHNIQUE. Kaoru Kawase and Kiyoshi Hayakawa (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 13: 448-52(Dec. 1964). (In Japanese)

The gamma-ray induced graft copolymerization of styrene on cellulose acetate yarns was carried out by a pre-irradiation technique in air, and the effects of various solvents on graft copolymerization were studied mainly from the viewpoint of the chain transfer. The aromatic hydrocarbon solvent that has a larger side chain decreased the degree of polymerization of the grafted polystyrene and also the percentage of grafting more markedly, and a remarkable decrease in both quantities was observed when carbon tetrachloride was added. By assuming that the process of chain transfer in the homogeneous system is applicable to this heterogeneous reaction, the transfer constants for solvents with styrene and the activation energy of the chain transfer for benzene were calculated from the dependence of both quantities on the concentration of monomer. The agreement between the calculated values and those formerly reported for the thermal polymerization of styrene was obtained. (auth)

26413 INFRA-RED SPECTRA AND CHROMATOGRAPHIC FRACTIONS OF IRRADIATED LINOLEIC AND LINOLENIC ACIDS. Robert Austin Milch and Gerald A. Klassen (Johns Hopkins Univ., Baltimore). Nature, 205: 1106-8(Mar. 13, 1965).

The hypothesis that cross-linking or related interactions between lipid hydroperoxides and aortic wall proteins may be the primary biochemical events in human atherogenesis is discussed. It is pointed out that available data suggest that even if fatty hydroperoxides are present in large amounts in tissues, such as the atherosclerotic human aorta, they are not very likely to be involved in interchain cross-linking reactions with the fibrous proteins of the aortic wall. An experiment was devised to test whether significant quantities of fatty hydroperoxides could be detected under conditions that simulate those of ordinary household cooking operations or of special environmental conditions. Linoleic and linolenic acids were exposed to thermal, ultraviolet, and γ radiations to provide test samples for experimental conditions considered severe. Infrared spectra were obtained for each sample, methyl esters were determined by gas-liquid chromatography, and the fatty acid composition of each of the fractions was determined. Results indicate that if hydroperoxides were present in either of the experimental conditions used they were present only to a very small degree. It is concluded that stable fatty hydroperoxides are not very likely to be major constituents either of foods cooked in most Western societies or in the atherosclerotic vessel walls of persons in these societies. (C.H.)

26414 EFFECTS OF RADIATION AND DOPING ON THE CATALYTIC ACTIVITY OF MAGNESIUM OXIDE ON THE THERMAL DECOMPOSITION OF POTASSIUM PERCHLORATE. Eli S. Freeman and David A. Anderson (Picatinny Arsenal, Dover, N. J.). Nature, 206: 378-9 (Apr. 24, 1965).

Gamma radiation and lithium and iron doping were used to investigate the relation between the electronic and physical structure and the catalytic activity of magnesium oxide. Thermogravimetric analysis was used to examine the changes in the thermal decomposition characteristics of potassium perchlorate in the presence of the catalyst. In the presence of magnesium powder the temperature at which decomposition became apparent was lowered by 34° and at one-half decomposition the temperature was lowered by 28°. However, the irradiated MgO was significantly less effective as a catalyst than the unirradiated oxide. Irradiation increased the temperature at which decomposition was first observed by 12° and the half-way decomposition temperature was 8° higher for the sample containing the irradiated MgO. During irradiation the MgO underwent slight decomposition. In other experiments the most effective catalyst was found to be the Li^+ ion-doped oxide, next the pure oxide, and least effective was the Fe^{3+} ion-doped MgO. The results are consistent with a positive hold theory for catalytic activity. (P.C.H.)

26415 RADIATION CARBONYLATING OF ALKANES BY CARBON MONOXIDE. E. P. Kalyazin and N. M. Baranova. Neftekhimiya, 4: 275-9(1964). (In Russian)

Carbonyl compounds were formed by the action of γ radiation on n-alkanes in the presence of carbon monoxide. The products of the reaction included aldehydes and ketones with the composition C_{n+1} (n is the number of C atoms in the hydrocarbon) and aldehydes of the composition C_3 to C_{n-1}. The effect of the CO pressure and the temperature on the yield and composition of the carbonylation products was investigated. (tr-auth)

26416 RADIOLYSIS OF CYCLOHEXANE. INFLUENCE OF TEMPERATURE AND STATE OF AGGREGATION OF

CYCLOHEXANE. V. I. Makarov and L. S. Polak. Neftekhimiya, 4: 314-19(1964). (In Russian)

The marked effect of the state of aggregation on the yields from radiolysis of cyclohexane, produced as a result of the break of C–C bonds, was established. The yields of the products from the breaking of the C–H bond (cyclohexene and dicyclohexyl) did not change on changing the aggregation state solid–liquid. Yields of cyclohexene and dicyclohexcyl did not depend on temperature in the interval from –196 to +50°C, but the yield of hydrogen was slightly dependent on temperature. The radiochemical yields of product fragments C_1–C_4 were determined at doses of xx 3×10^{19} ev/ml. Product fragment yields were explained on the basis of the introduction of three types of monomolecular decompositions of excited molecules of cyclohexane and possible "cellular effects" in yields of these products. (tr-auth)

26417 RADIATION-CATALYTIC CONVERSIONS OF CYCLOHEXANE. G. M. Zhabrova, V. B. Kazanskii, V. I. Vladimirova, B. M. Kadenatsi, and G. B. Pariiskii. Neftekhimiya, 4: 753-62(1964). (In Russian)

At temperatures from –196 to 20°C, the mutual effects of ionizing radiation (γ beams of ^{60}Co) and catalysts with different electronic properties (insulators, semiconductors, and metals) were investigated with respect to dehydrogenation and other conversions of cyclohexane in adsorbed layers. The selectivity of the reaction of the solid compounds studied in radiation catalytic processes was explained in comparison with thermal catalytic processes and homogeneous radiolysis. The highest radiation catalytic activities characterized the oxide type of insulators (SiO_2, Al_2O_3, and aluminum silicate), practically non-operative in the usual catalytic processes even at high temperatures. The appearance of paramagnetic centers and absorbed C_6H_7 radicals in these catalysts was confirmed by the EPR method. The semiconductors and metals (NiO, ZnO, and Ni), active in the usual catalytic processes, had little radiation catalytic activity. The appearances of paramagnetic centers and adsorbed radicals was not detected in these compounds. The dependence of radiochemical yields of hydrogen on charging the surface of SiO_2 with adsorbed cyclohexane was established. (tr-auth)

26418 RADIATION-INDUCED THERMOLUMINESCENCE OF LIGHT AND HEAVY WATER. Yohta Nakai and Koji Matsuda (Japanese Assn. for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 11-17(Nov. 1964). (In Japanese)

A comparison of the thermoluminescence intensity between irradiated light and heavy water was made to obtain some information of isotope effects on irradiated materials. In the case of low-dose irradiation ($<10^5$ R) only one peak at –100°C is observed, but for higher doses ($10^6 \sim 10^8$ R) a new peak at –160°C is observed. The glow peak in heavy water at 160°C is 20 times as high as the glow peak in light water for the high dose region. The effects of impurities on the thermoluminescence of both kinds of water are not significant at higher doses. Results may indicate that a new trapping center is created by irradiation and that the number of centers is different for the two waters. (auth)

26419 RADIATION-INDUCED GRAFT COPOLYMERIZATION TO CELLULOSE. XVII. STABILITY OF ACTIVE CENTERS. Fujiko Kimura and Toshio Okada (Japanese Assn. for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 33-8(Nov. 1964). (In Japanese)

The stability of active centers for radiation-induced grafting was studied. The activity of grafting decreased with raised irradiation temperature and the grafting hardly proceeded when cellulose was preirradiated above 35°C. The active centers rapidly decayed when heated and when in contact with moisture after irradiation. When the sample irradiated was stored at 50°C in 100% relative humidity for two hr, the grafting did not occur. The rate of grafting did not decrease if the sample was irradiated at relatively high temperatures and after the irradiation stored at low temperatures. The active centers seem to decay mainly while the sample is stored after irradiation. The reproducibility of grafting showed comparatively good results when irradiation and grafting were carried out under identical conditions. (auth)

26420 RADIATION-INDUCED GRAFT COPOLYMERIZATION TO CELLULOSE. XVIII. PRELIMINARY STUDIES ON THE EFFECTS OF OXYGEN ON GRAFTING BY PREIRRADIATION TECHNIQUE. Toshio Okada and Fujiko Kimura (Japanese Assn. for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 39-46(Nov. 1964). (In Japanese)

Effects of oxygen on preirradiation grafting of styrene onto cellulose were studied. Experiments were carried out on grafting by a preirradiation technique using electron beams from a Van de Graaff accelerator. It was observed that grafting occurred smoothly in pressures of less than 1×10^{-2} mm Hg. Some experiments were carried out with grafting mixtures flushed with oxygen-free nitrogen. The reaction proceeded smoothly under nitrogen gas containing oxygen of less than 0.02 percent. (auth)

26421 RADIATION-INDUCED GRAFT COPOLYMERIZATION TO POLY (VINYL CHLORIDE). I. GRAFTING ONTO POLY (VINYL CHLORIDE) POWDER WITH BINARY MIXTURES OF STYRENE AND ACRYLONITRILE. Toshio Okada and Ayako Torikai (Japanese Assn. for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 47-59(Nov. 1964). (In Japanese)

Radiation-induced grafting of binary mixtures of styrene and acrylonitrile onto poly (vinyl chloride) powder at 30°C was studied. The different types of polymers obtained by suspension and semisuspension polymerization were investigated. The curve representing the rate of grafting as a function of the composition of the monomer mixtures shows a complex shape. A very marked maximum of per cent of graft was observed in the case of emulsion-polymerization-polymer at 97 mole % and a minimum at 16.3 mole % acrylonitrile. Such a maximum was interpreted in terms of gel effect and the diffusion of the monomers due to the precipitation of the copolymer in the reaction medium for acrylonitrile content higher than 95%. Some kinetical consideration was given in order to elucidate the mechanism of the grafting in the range of less than 75% acrylonitrile in comonomers. Behaviors of grafting of suspension-polymerized polymer were compared with semisuspension-polymerized. The influenoe of treatments before grafting and of the structure of polymer on grafting was remarkable at the earlier stage of the grafting. (auth)

26422 RADIATION-INDUCED GRAFT COPOLYMERIZATION TO POLY (VINYL CHLORIDE). II. GRAFTING OF ACRYLONITRILE ONTO POLY VINYL CHLORIDE FIBERS. Toshio Okada and Ayako Torikai (Japanese Assn. for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 61-70(Nov. 1964). (In Japanese)

For the purpose of improvement of heat stability, the grafting of acrylonitrile to poly (vinyl chloride) fibers was studied by the use of direct irradiation. Some experiments of grafting with styrene and styrene-acrylonitrile were also carried out. The effect of composition of comonomer on the rate of grafting was nearly the same as in the case of grafting to poly (vinyl chloride) powder. The rate of grafting of acrylonitrile onto poly (vinyl chloride) fiber in a stretched state was not much different from that in a non-stretched state. Some properties of grafted fibers were measured. The acrylonitrile graft fiber prepared in a stretched state at 60°C up to a grafting degree of 42 per cent showed a thermal shrinkage of less than 10 per cent over a wide temperature range up to 250°C, whereas the original fiber showed a thermal shrinkage of more than 80 per cent at the breaking temperature of 185°C. Although the thermal stability of graft fibers was remarkably improved, the mechanical properties of fibers were scarcely changed by this method of irradiation grafting. (auth)

26423 RADIATION-INDUCED GRAFT COPOLYMERIZATION OF METHACRYLAMIDE TO POLY (VINYL ALCOHOL) IN HOMOGENEOUS SYSTEM. Yasushi Asano and Toshio Okada (Japanese Assn. for Radiation Research

on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 71-82(Nov. 1964). (In Japanese)

Grafting of methacrylamide to poly (vinyl alcohol) was carried out in aqueous solution by the mutual radiation technique. Experiments of turbidimetric titration showed that irradiation products were a mixture of graft copolymers with poly (vinyl alcohol) and polyacrylamide. Fractional precipitation was further carried out of the irradiation products in aqueous solution with isopropanol, and the fractions were characterized by turbidimetric titration and infrared spectroscopy. Isolation of graft copolymer was difficult for the irradiation products at a higher dose. Graft efficiencies of acrylamide to poly (vinyl alcohol) were 80% for the grafting induced by doses smaller than 3.2×10^4 R. Nitrogen content and viscosity of the graft copolymer fraction suggest that a backbone of poly (vinyl alcohol) molecule has about 15 short branches of polymethacrylamide. It seems that graft copolymers of a lower degree of conversion are contained in other fractions. (auth)

26424 POLYMERIZATION OF CYCLIC ETHERS IN THE PRESENCE OF MALEIC ANHYDRIDE. I. RADIATION AND ULTRAVIOLET LIGHT INDUCED POLYMERIZATIONS OF TRIOXANE AND 3,3-BIS(CHLOROMETHYL)OXETANE IN THE LIQUID STATE. Koichiro Hayashi and Koichi Takakura (Japanese Assn. for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 139-47(Nov. 1964).

It was previously reported that cyclic ethers, such as trioxane (T) and 3,3-bis(chloromethyl)oxetane (BCMO), can be polymerized only in the solid state by ionizing radiation to form well-oriented polymer crystals. On the other hand, it is well known that these monomers polymerize when a strong cationic catalyst, such as BF_3-etherate or $SnCl_4$, is used. No polymerization occurs at all by radical initiation. During recent studies on the radiation-induced solid state polymerization of binary monomer systems, it was found that the polymerization of trioxane and BCMO could be remarkably accelerated by the addition of suitable amounts of maleic anhydride (MAH), and moreover, the polymerization of this system took place even in the liquid state. Furthermore, it was discovered that polymerization of this system easily occurred by benzoyl peroxide (BPO) in the liquid state. The present report is concerned with the study of such polymerization phenomena. Part I relates to the results of radiation- and ultraviolet-induced polymerization of trioxane and BCMO. (auth)

26425 POLYMERIZATION OF CYCLIC ETHERS IN THE PRESENCE OF MALEIC ANHYDRIDE. III. INVESTIGATION OF THE POLYMERIZATION MECHANISM. Koichi Takakura and Koichiro Hayashi (Kurashiki Rayon Co., Ltd., Japan). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 155-60(Nov. 1964).

In order to elucidate the reaction mechanism of both the radiation-induced polymerization and BPO-catalyzed polymerizations of cyclic ethers in the presence of MAH, the development of color during reaction, and copolymerization of oxetane derivatives are investigated. Polymerizations of other cyclic ethers are also briefly examined. In this paper (Part III), the study of the reaction mechanism is reported. (auth)

26426 THE RADIATION INDUCED POLYMERIZATION IN ELECTRIC FIELD AT LOW TEMPERATURE. Masahiro Sakamoto and Koichiro Hayashi (Toho Rayon Co., Ltd., Japan). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 161-7(Nov. 1964). (In Japanese)

The radiation-induced polymerization of styrene in methylene dichloride, of methyl methacrylate in isopropylamine, and of acrylonitrile in triethylamine at –78°C in an electric field (0 ~ 5000v) was studied. The rate of polymerization of styrene in methylene dichloride at –78°C increases in an electric field. The rates of polymerizations of methyl methacrylate in iso-propylamine and of acrylonitrile in triethylamine at –78°C decrease in an electric field. It is well known that the former polymerization proceeds by the cationic mechanism but the latter by the anionic mechanism. It is supposed, therefore, that the anionic species can be removed from the reaction system owing to the electric field, so that the rate of polymerization initiated by cationic species is increased. (auth)

26427 IONIZATION AND DISSOCIATION OF METHYL-KETONE UNDER ELECTRON IMPACT. Kozo Hirota and Motoyoshi Hatada (Japanese Assn. for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 169-73(Nov. 1964). (In Japanese)

Calculations were carried out to predict the ionization potentials and bond-scission probabilities of methyl ketones by the extended method of group bond orbitals. The calculated ionization potentials agree with measured ones. Close correlation is found to exist between calculated charge distributions and bond-scission probabilities estimated from the mass spectra of these compounds. (auth)

26428 RADIOLYSIS OF METHYLAL AND ETHYLENE GLYCOL DIMETHYL ETHER. Kozo Hirota and Junichi Takezaki (Japanese Assn. for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 175-86(Nov. 1964). (In Japanese)

Radiolysis of methylal was compared with that of ethylene glycol dimethyl ether (EGDE), which is similar to methylal in structure, at room temperature. It was found that (a) radiolysis of methylal was different from that of EGDE in the dependence on dose rate and total dose of the products; (b) the C–O bond adjacent to the methoxy group of methylal was most susceptible to scission, but the scission was the central C–C bond in EGDE; (c) aldehydes, ketones, olefins, and paraffins except for methane were not detected in the products resulting from radiolysis of methylal and EGDE. The above conclusion based on gas chromatographic and mass spectroscopic data appeared to be plausible on the basis of ESR spectra. (auth)

26429 GAMMA-RAY RADIOLYSIS OF ETHYLENE GLYCOL DIACETATE. Kozo Hirota and Toshiro Isoya (Japanese Assn. for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 187-92(Nov. 1964). (In Japanese)

Radiolysis of air-free $CH_3\overset{\overset{O}{\|}}{C}OCH_2CH_2O\overset{\overset{O}{\|}}{C}CH_3$ by ^{60}Co γ rays was studied at room temperature. The irradiation yields five gaseous and six liquid products. The gaseous products are H_2, CH_4, CO, CO_2, and C_2H_6. The liquid products are acetaldehyde, acetone, methyl acetate, ethyl acetate, n-propyl acetate, and methyl cellosolve acetate. The G value of total gaseous products is 2.3. The minimum G value of decomposition is 1.5. (auth)

26430 RADIATION INDUCED OXIDATION OF p-XYLENE. Kozo Hirota and Norikatsu Ohtsuka (Japanese Assn. for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 193-203(Nov. 1964). (In Japanese)

By use of the radiation-induced oxidation reaction of p-xylene, irradiation effects on several catalysts (V_2O_5, cobalt naphthenate, and ZnO) were studied. The reactions were carried out at 175°C for 1 ~ 4 days using an autoclave charged with O_2 at 20 atm. Irradiation was carried out by γ rays from ^{60}Co, the dose rate being 5.55×10^4R/hr. In each case, the main product was p-toluic acid, while terephthalic acid was not produced. The irradiation effect on ZnO catalyst, however was exceptional in comparison with the other two catalysts. (auth)

26431 ANION RADICAL AS AN INTERMEDIATE IN THE RADIATION-INDUCED POLYMERIZATION OF α-METHYLSTYRENE. Kozo Hirota and Meiseki Katayama (Hokkaido Univ., Sapporo). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 205-14(Nov. 1964). (In Japanese)

Gamma-ray-induced polymerization of α-methylstyrene was studied with sodium-dried monomer. Though the inhibition of the reaction by DPPH and the absence of co-polymer in the isobutylene mixture were explained by the radical mechanism hitherto proposed, a more satisfactory interpretation of the data was reached by postulating an anion radical as a reaction intermediate. The effect of solid additives and the significance of irradiation with high dose rate are also discussed. (auth)

26432 PHOTOINDUCED CHANGE OF ORGANIC FREE RADICALS AS STUDIED BY ESR. IV. ETHYLENE. Isamu Nitta and Shun-ichi Ohnishi (Japanese Assn. for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 215-19(Nov. 1964). (In Japanese)

Electron-irradiated solid ethylene showed a 12-line ESR spectrum due to the ethyl radical. The spectrum, however, gradually decayed even at −196°C and completely disappeared after 20 hr. A five-line spectrum of the splitting value 15 gauss remained after the 12-line spectrum; this component was rather stable at −196°C. Upon uv-illumination the five-line spectrum was gradually converted to the 12-line spectrum. This conversion process was studied to clarify its molecular mechanism. (auth)

26433 DECAY BEHAVIOR OF FREE RADICAL IN IRRADIATED n-OCTACOSANE-UREA COMPLEX. Isamu Nitta and Shun-ichi Ohnishi (Japanese Assn. for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 229-34(Nov. 1964). (In Japanese)

Decay of the alkyl-type radical $-CH_2-\dot{C}H-CH_2-$ produced in irradiated n-octacosane-urea adduct was studied in comparison with decay of the same radical in irradiated n-octacosane. In the adduct the decay was much slower, while the activation energy for the decay reaction was much larger (43.3 kcal/mole for the adduct and 23.5 kcal/mole for n-octacosane). (auth)

26434 ESR STUDY OF IRRADIATED SOLID CYCLOALKANES. Isamu Nitta (Japanese Assn. for Radiation on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 235-8(Nov. 1964). (In Japanese)

A study of the electron spin resonance spectra of radicals produced by electron-irradiation at −196°C in various polycrystalline cycloalkanes revealed that in all cases the main species observed after irradiation is the parent cycloalkyl radical. Some of these show a notable motional narrowing or structural deformation on warming. It is found that in the solid state the methylenic group of the cyclopentyl, cyclohexyl, cycloheptyl and cyclooctyl radicals are twisted because of the non-planar structure of the parent molecules, while in the cyclobutyl radical the four β-hydrogens are equivalent. (auth)

26435 PHYSICO-CHEMICAL PROPERTIES OF GLYCINE SOLUTION DURING IRRADIATION. Giichi Yoshii (Osaka Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 362-9(June 1964).

The dissociation and cross linking of glycine molecules in an aqueous solution admixed with ^3H_2O, when β-irradiated, were studied by the ESR technique. The free radicals formed in the glycine solution were found to be $^+NH_3\dot{C}HCO_2^-$ and $\dot{C}H_2CO_2^-$ by examining the doublet and triplet patterns. The reaction mechanisms were as follows: $^+NH_3CH_2CO^- + OH \rightarrow {}^+NH_3\dot{C}HCO_2^- + H_2O$ (1), $^+NH_3CH_2CO_2^- \xrightarrow{\beta\text{-ray}} {}^+NH_3 + \dot{C}H_2CO_2^-$, (2). The equation (1) is caused by direct action of the radiation, while the equation (2) is caused by indirect action. The dielectric increment increased gradually from the beginning to 5×10^4 rads, and then it increased remarkably thereafter in the 3M glycine solution at 2 Mc/sec. This may be explained as results of the following reactions: $^+NH_3\dot{C}HCO_2^- + {}^+NH_3CHCO_2 \rightarrow 2(NH_3CHCO_2^-)$ (3), and $^+NH_3\dot{C}HCO_2^- + CH_2CO_2H \rightarrow HO_2C{\cdot}\dot{C}H_2 + NH_3CHCO_2^-$ (4). The increase of the dielectric increment can be explained qualitatively, but not quantitatively. Therefore, it is thought that reactions proceed further, these products interacting electrostatically with each other. (NSA of Japan)

26436 AXIALLY SYMMETRIC PARAMAGNETIC COLOR CENTERS IN FLUORAPATITE. W. W. Piper, L. C. Kravitz, and K. R. K. Swank (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 138: A1802-14(June 14, 1965).

The x-ray coloration of synthetic calcium fluorophosphate (fluorapatite) crystals is shown to result from the presence of fluorine vacancy defects. Three of these defects were studied by correlating their optical absorption bands with their electron-paramagnetic-resonance spectra, and by application of the electron-nuclear-double-resonance technique to measure the ^{19}F and ^{31}P hyperfine interactions. The models proposed for these three axially symmetric defects consist of an electron trapped at (a) an isolated F^- ion vacancy, (b) a F^- ion divacancy associated with a charge-compensating $O^=$ ion, and (c) a second configuration of defect (b). Several paramagnetic hole-excess centers are also described. No optical absorption bands between 0.3 and 1.5 μ were observed for the hole centers. (auth)

26437 RADIATION AND POLYMERS. I. M. Barkalov (Inst. of Chemical Physics, Academy of Sciences, USSR). Priroda, No. 2, 13-17(Feb. 1965). (In Russian)

Radiochemical methods in polymer chemistry are discussed. The effects on ionizing radiation on monomers, polymerization of solids, radiation point welding, insulation, and radiation vulcanization are briefly reviewed. (R.V.J.)

26438 ELECTRON SPIN RESONANCE OF X-IRRADIATED TARTRONIC ACID. Grace C. Moulton and H. T. Crenshaw (Univ. of Alabama, University). Radiation Res., 25: 139-45(May 1965).

The X-band ESR spectra of single crystals of tartronic acid monohydrate, $HOCH(CO_2H)_2 \cdot H_2O$, x irradiated at 50 kv were observed. One radical species of the radiation damaged crystal was analyzed as $HOCH(CO_2H) \cdot H_2O$, due to a broken C—C bond. The unpaired spin resides principally on the carbon, with coupling to the CH hydrogen and a second weaker coupling to the hydroxyl hydrogen. (auth)

26439 KINETICS OF SODIUM PHENYLPHOSPHATE HYDROLYSIS BY ^{60}Co γ-IRRADIATED ALKALI PHOSPHATASE. M. M. Dragilev, G. M. Zharkova, and E. B. Nikol'skaya (Medical Inst. of Sanitation and Hygiene, Leningrad). Radiobiologiya, 5: 317-18(1965). (In Russian)

The ratio of the initial rate of hydrolysis of sodium phenylphosphate by irradiated alkali phosphatase to that by nonirradiated was independent of the substrate concentration at pH 9.0 and 9.3 at 37°C. The data indicate that the gamma irradiation does not change the kinetic constants but only decreases the active enzyme concentration. (IIC-M.G.)

26440 ON THE APPEARANCE OF TRITIUM ACTIVITY IN ORGANIC PRODUCTS DURING A PROTRACTED IRRADIATION OF HYDROCARBONS AND AMINES IN AMPOULES IN A REACTOR. E. N. Avdonina and B. V. Karasev. Radiokhimiya, 6: 631(1964). (In Russian)

In "hot-atom" studies, the reaction products of N-containing compounds and hydrocarbons formed during irradiation are usually analyzed by transforming the ^{14}C compounds into CO_2 or $BaCO_3$. During such tests, small amounts of organic compounds were exposed to a neutron flux of 7×10^{13} n/cm²-sec for 200 hours, and the mixture kept in quartz ampoules. The products, the activity of which ranged from 1 to 7×10^5 decompositions per minute, were subjected to gas chromatographic tests, which showed that nearly all of the activity was restricted to the H-fraction; the liquid phase was activated to a much lesser extent. Study of the β energy spectrum revealed that the activity is due to the presence of tritium. Analyzing the SiO_2 of the ampoules showed that 2×10^{-5} g of Li is present in per g of SiO_2; this amount is sufficient to account for the observed activity. The recoil atoms of T in the gas phase are probably stabilized by collision with H atoms during radiolysis; thus, most of the activity is due to the presence of HT. (TTT)

26441 CHEMICAL CHANGES IN β DECAY OF ^{210}Bi(RaE) IN PENTAPHENYLBISMUTH CRYSTALS. V. D. Nefedov, V. E. Zhuravlev, M. A. Toropova, and A. V. Levchenko. Radiokhimiya, 6: 632(1964). (In Russian)

The chemical changes taking place during the β decay of pentaphenylbismuth were studied. The decay of ^{210}Bi contained in $Bi(C_6H_5)_5$ led to the formation of the molecular ions $[Po(C_6H_5)_5]^+$. If the decay of these ions followed the same scheme as that of the corresponding Te compounds, the main decay products should be $Po(C_6H_5)_4$, not previously reported in the literature, and $Po(C_6H_5)_3X$. This was studied by exposing $Bi(^{210}Bi)(C_6H_5)_5$ to a neutron flux of 5×10^{13}, collecting the decay products at +20°C and at liquid-air

temperature for a period of 5 half lives, and examining them by paper chromatography. It was found that the following products were formed: $Po(C_6H_5)_3X$, 95 ± 3%; $Po(C_6H_5)_2$, 5 ± 3% at room temperature; and $Po(C_6H_5)_3X$, 57 ± 3% at liquid-air temperature. The remainder of the Po at the latter temperature belonged to $Po(C_6H_5)_2$ and $Po(C_6H_5)_4$, which could not be separated because of the similarity of their chromatographic behavior. The data agree with the findings obtained when studying the changes of $Sb(^{125}Sb)(C_6H_5)_3$ during β decay. (TTT)

26442 RADIOLYSIS OF THYMINE IN AQUEOUS SOLUTIONS: CHANGE IN SITE OF ATTACK WITH CHANGE IN pH. L. S. Myers, Jr., J. F. Ward, W. T. Tsukamoto, D. E. Holmes, and J. R. Julca (Univ. of California, Los Angeles). Science, 148: 1234-5(May 28, 1965). (UCLA-12-539)

In the radiolysis of thymine in neutral air-saturated solutions the principal site of attack is at the 5,6 double bond; in strongly alkaline solutions the attack shifts to the 5-methyl group. The shift correlates well with a model based on two changes in the reaction path as the pH is increased. (auth)

26443 γ-RAY IRRADIATION OF AQUEOUS SOLUTION OF L-ASCORBIC ACID IN VACUUM. Seiichi Ishikawa and Atsuko Hida (Jissen Women's Univ., Japan). Shinku Kagaku, 12: No. 6, 2-7(Dec. 1964). (In Japanese)

An aqueous solution of L-ascorbic acid in ampoules was irradiated with 800 curies ^{60}Co during 53 days, that is, with 2544×10^5 R in various periods, and changed to a brownish color. After vacuum drying of the products, melting point, acidity, polarity, infrared and ultraviolet absorption spectrum and paper chromatography were measured. From these measurements, it was concluded that the product contained condensation products of furfural with other substances, which were formed from L-ascorbic acid irradiated by γ rays. (auth)

26444 RATES OF REACTION OF THE HYDROXYL RADICAL. J. K. Thomas (Argonne National Lab., Ill.). Trans. Faraday Soc., 61: 702-7(Apr. 1965).

The pulse radiolysis technique was used to establish that I_2^- is the product of reaction of OH radicals with iodide ions. The rate of formation of I_2^- was measured and gave $k_{OH+I^-} = 1.02 \pm 0.13 \times 10^{10} M^{-1}sec^{-1}$. Various solutes were found to decrease the yield of I_2^- by competing with iodide ion for OH radicals. Their rates of reaction were subsequently measured relative to k_{OH+I^-}. A transient absorption due to the OH radical was observed below 3000 A in aqueous solution. This absorption was doubled by the addition of H_2O_2 and N_2O, due to the reactions $e^-_{aq} + N_2O \rightarrow OH + N_2$ and $e^-_{aq} + H_2O_2 \rightarrow OH^- + OH$. (auth)

26445 RADIOLYSIS OF AQUEOUS SOLUTIONS CONTAINING NITRITE IONS AND NITROUS OXIDE. F. S. Dainton and S. R. Logan (Leeds Univ., Eng.). Trans. Faraday Soc., 61: 715-22(Apr. 1965).

In the radiolysis of aqueous solutions containing N_2O and nitrite ions, the yield of reducing radicals appeared to increase with the solute concentrations. This increase was much greater than the decrease in G_{H_2} and therefore cannot be wholly attributed to increased scavenging within the spur of the reducing radicals, which would otherwise have combined with another radical. The results were consistent with an initial yield, of G about unity, of a species which, if it were the excited water molecule H_2O^* would have a half life of about 10^{-6} to 10^{-7} sec, which can react with N_2O to produce N_2 and whose relative rate constant with NO_2^- and N_2O is comparable with that of the solvated electron. (auth)

26446 SOLUTE SCAVENGING EFFECTS IN REGIONS OF HIGH RADICAL CONCENTRATION PRODUCED IN RADIATION CHEMISTRY. E. Hayon (CEN, Saclay, France). Trans. Faraday Soc., 61: 723-33(Apr. 1965).

Solutes, which act as oxidizing agents (e.g., H^+, NO_3^-, N_2O) or reducing agents (e.g., I^-, Tl^+, OH^-), are shown to scavenge the radicals $(H_2O)^-$ and OH produced in regions of high radical concentration (spurs) in the radiation chemistry of water, resulting in a decrease of the combination reaction $(H_2O)^- + OH \rightarrow H_2O + OH^-$ to form water. This increase in radical yields depends upon the concentration of solutes $C_S(M)$ and the rate constants for reaction with the radicals, $k_{RS}(M^{-1}sec^{-1})$. Using a method of normalization of one solute against another it is shown that when $k_{RS}C_S \leq 10^7 sec^{-1}$, $G_{(H_2O)^-} = 2.30$, $G_{OH} = 2.25$, $G_H = 0.55$, and for values of $k_{RS}C_S > 10^7 sec^{-1}$ the yields of $(H_2O)^-$ and OH increase proportionally to the product of k_{RS} and C_S. Values of k_{RS} obtained from scavenging $(H_2O)^-$ and OH in the spurs were the same as those obtained for reaction with the radicals in the bulk of the solution. (auth)

26447 RADICAL AND MOLECULAR YIELDS IN THE RADIOLYSIS OF ALKALINE AQUEOUS SOLUTIONS. E. Hayon (CEN, Saclay, France). Trans. Faraday Soc., 61: 734-43(Apr. 1965).

The radiation chemistry of alkaline aqueous solutions of nitrate + formate ions, ferricyanide + formate + O_2, and ferricyanide + ethanol + O_2 was studied in the pH range 6 to 14. The yields of oxidizing and reducing radicals formed from the water increased at pH's above 12, while the yield of H_2 remained essentially unchanged, and the yield of H_2O_2 decreased with increasing pH. The mechanism of the dependence of radical yields on $[OH^-]$ is suggested to be due to scavenging by OH^- ions of OH radicals in regions of high radical density (spurs), $OH + OH^- \rightarrow H_2O$, with $k_7 = 6.2 \pm 1.5 \times 10^9 M^- sec^{-1}$. This scavenging resulted in a decrease of the back reaction to form water: $(H_2O)^- + OH \rightarrow H_2O + OH^-$. Using a method of normalization the rate constants of the reactions of OH radicals with $HCOO^-$, isopropanol, ethanol, and methanol were derived at pH = 12.45. (auth)

26448 STUDIES ON X-AGENT. XL. SCATTERING OR REFLECTION OF X-AGENT BY A WALL. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 15: 195-200(Oct. 1964).

A soft component of the so-called X-agent which is said to alter the sedimentation behavior of a suspension of the dye neutral red was further examined. The present report describes the agent's being scattered or reflected by a substance as is ordinary sunlight, but through scattering the agent appears altered in character, a phenomenon which cannot be observed with sunlight. Thus sedimentation of suspension of the dye was greatly affected when the pigment suspension was placed near a wall. In general, the sedimentation-inhibiting action of the X-agent was decreased markedly as the distance from the wall was increased, but the inhibition was strongest when the pigment solution was placed at a certain distance from the wall, the closer to the wall the less the action of the agent. This phenomenon was observed despite the fact that the pigment suspensions contained in a row of test tubes were also exposed to sunlight. An analogous effect of a wall could be demonstrated in erythrocyte-sedimentation rates. The rates were increased strongly near a wall and especially as the distance from the wall was increased to some extent, but this occurred only when sedimentation tubes were slightly inclined towards the wall. These findings are said to support the conception that the X-agent is scattered by a substance with which it comes into contact and through the scattering it is increased in its action. (BBB)

26449 STUDIES ON X-AGENT. XLI. EFFECT OF X-AGENT ON ALKALINE, AQUEOUS SOLUTIONS OF NEUTRAL RED. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 15: 217-30 (Dec. 1964).

Further studies were conducted on the hypothetical soft radiation said to be closely related to sunlight which affects the precipitation or the crystallization of neutral red. In the present report the color of a dilute aqueous solution of neutral red, which is made slightly alkaline, is also alleged to be sensitive to this soft agent. It is possible to measure the agent readily on the basis of this observation. The soft agent which has influence on the color of the pigment solution is demonstrated chiefly in sunlight. However, artificially produced radiations, such as thermal radiation and uv light, have no similar action. The soft agent, when present in sunlight, enhances strongly

the discoloration of the pigment, but the same agent reveals an entirely opposite action on passing through a curtain; that is, it inhibits the discoloration. Similar inversion of the effect occurs in the morning and in the evening when the sunlight is weak. Such an inversion phenomenon is explained by assuming that the discolorizing effect of the soft agent is not essential to the agent, but the effect is developed by some solar radiation which can interact with the soft agent to reverse its action, so that without the interaction of the solar radiation the soft agent inhibits the discoloration rather than promoting it. The color of the pigment solution is very sensitive to the soft agent, but it is affected also by a hard X-agent which can pass through a 5-cm lead shield. The effect on the pigment solution of such hard agent is not so strong as that of the soft agent, but it is demonstrable if a proper method is employed. This hard agent prevails at night as well as in the day. The hard agent gradually alters with the progress of the day. The sun appears to have no influence on the hard agent. However, the soft agent is closely associated with the sun and in most cases emanates from a southerly direction, whereas the hard agent tends to progress along a direction extending south and north. (BBB)

26450 M-CENTER FORMATION IN X-RAY-IRRADIATED KCl CRYSTALS. Hans Gerhard Dahnke and Klaus Thommen (Universitat, Bonn). Z. Physik, 184: 367-81 (Apr. 15, 1965). (In German)

The production of F- and M-centers in KCl by x irradiation was studied at temperatures between −20 and 50°C. The optical absorption measurements could be conducted without interrupting the x irradiation. The results can be summarized as follows: In Harshaw KCl crystals the number of F-centers created by the so-called fast coloration process was proportional to the height of the absorption band at 204 mμ prior to the irradiation. The F-centers formed by the fast process did not contribute to the formation of M-centers. In crystals with a strong absorption band at 204 mμ unstable M-centers were observed, which decayed rapidly after the cessation of the x irradiation. Their concentration was found to be independent of the F-center concentration. At temperatures below 0°C the relation between the concentration of the stable M-centers and the F-center concentration could not any longer be represented by $[M] = k_{12} \cdot [F_1] \cdot [F_2] + k_{22} \cdot [F_2]^2$, F_1 and F_2 referring to the F-centers created respectively by the fast and the slow coloration process. Except at very low F_2-center concentrations however the relation $[M] = k_0 + k_2 \cdot [F_2]^2$ represented the experimental data at all temperatures between −20 and 50°C. At constant temperature k_2 varied with L, the x-ray energy absorbed per unit time and unit volume, according to $1/k_1 = a + bL + cL^2$. The temperature dependence of a^{-1}, b^{-1}, and c^{-1} could be approximated by Boltzmann factors. The corresponding activation energies were $E_a = 0.12$ ev, $E_b = 0.53$ ev, $E_c = 0.97$ ev. (auth)

26451 INVESTIGATION OF RADIATION STABILITY OF POLYCONDENSATE CATIONITES KU-5, KU-6, AND EO-7. E. D. Kiseleva, K. V. Chmutov, and M. M. Klientovskaya (Inst. of Chemical Physics, Academy of Sciences, USSR). Zh. Fiz. Khim., 39: 771-3(Mar. 1965). (In Russian)

During exposure of the cationites in distilled water 1.0N hydrochloric acid at doses of 0.2 to 1.5×10^{22} ev/g, the exchange capacity of EO-7 and KU-5 decreased 5 to 20% and their swelling was modified; the ion-exchange properties of KU-6 were not altered. The radiation stability of the cationites KU-5G and KU-6G were connected with the special electronic structure of the condensing nucleus of naphthalene and acenaphthene (KU-5G and KU-6G) and with the introduction in the system of hydroquinone. (tr-auth)

26452 TRANSIENT CHEMICAL SPECIES FORMED BY RADIATION. John W. Boag and Gerald E. Adams (Mount Vernon Hospital, Northwood, Middx., Eng.). p.64-85 of "Cellular Radiation Biology." Baltimore, The Williams and Wilkins Co., 1965.

Results produced by kinetic and flash spectroscopy since the discovery of the absorption spectrum of the hydrated electron are surveyed. Reactions of the hydrated electron are discussed with emphasis on reactions with benzophenone and metal ions. Rate constants for electron reactions obtained by kinetic spectroscopy are tabulated. Transient species in oxygenated water and biological molecules are considered. (H.G.D.)

Radiochemistry

See also Separation Processes and Procedures.

Refer also to abstracts 25860 and 27506.

26453 (KFK-258) UBER DAS VERHINDERN DER SPALT-JOD-VERFLUCHTIGUNG BEIM LOSEN VON UO_2-PROBEN. (Prevention of the Volatilization of Fission Iodine in the Dissolution of UO_2 Samples). D. Geithoff and V. Schneider (Kernforschungszentrum, Karlsruhe (West Germany). Institut fur Radiochemie). Apr. 1964. 10p. Dep.(mn).

It was shown that the oxidation of iodine to higher stages in HNO_3 solutions of medium concentration proceeds better with the addition of about 5 mol. % HCl to the solution. In 8M HNO_3 the dissolution velocity of UO_2 is still sufficient, but the iodine can be quantitatively retained in the solution. (tr-auth)

26454 (USNRDL-TR-831) A RAPID IODINE RADIOCHEMICAL PROCEDURE. A. E. Greendale, D. L. Love, and A. A. Delucchi (Naval Radiological Defense Lab., San Francisco, Calif.). Feb. 12, 1965. Contract AT(49-2)-1167. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A radiochemical procedure was developed to determine fission yields and radiation characteristics of short-lived iodine fission products. It separates iodine from other fission products of uranium in less than 10 seconds from the end of an irradiation, and gives high decontamination factors of iodine from Sn, Sb, Te, Xe, Cs, and Ba and high chemical yields. The sample to be irradiated is prepared by dissolving uranium peroxide in molten periodic acid. The melt is cooled, ground to a powder, and mixed with activated carbon. After irradiation, the periodic acid is decomposed with heat to yield iodine, oxygen, and water. The gaseous elemental iodine passes through a heated sintered-glass frit and is collected in carbon tetrachloride or in a cooled counting chamber. With this sample form, higher temperatures can be used than in conventional aqueous systems, thus enhancing the exchange of carrier and fission-product iodine. Radiochemical exchange of the carrier iodine with fission product iodine was shown by comparing the cumulative fission yields of ^{131}I and ^{133}I determined by this fast separation procedure with those determined by a conventional radiochemical procedure. It was also shown that carrier-free ^{131}I in both the iodide and iodate forms exchanges with the carrier iodine. (auth)

26455 THE SOLUBILITY OF AIRBORNE RADIOACTIVE PARTICLES. Marion R. Scalf and Joe O. Ledbetter (Public Health Service, Las Vegas, Nev., and Univ. of Texas, Austin). Am. Ind. Hyg. Assoc. J., 26: 161-4(Mar.-Apr. 1965).

Membrane filters of various pore sizes were used to collect airborne radioactive particles. The samples were counted for beta radioactivity, then washed with solvents. The filters were counted to determine the insoluble fraction, and the filtrate was passed through exchange resins to determine the gross ionic form. The radioactive particles showed about 40 per cent solubility in water at pH 7. The solubility increased with a pH change in either direction, but was greater for the low pH. The solubility also increased with decreasing particle size. (auth)

26456 AN APPARATUS FOR CONTINUOUS MEASUREMENT OF RADIOACTIVITY OF LIQUIDS IN SYSTEMS "SOLID-LIQUID." R. Despotovic and M. Mic (Inst. "Ruder Boskovic," Zagreb). Croat. Chem. Acta, 36: 237-9(1964).

The construction of an apparatus for continuous measurement of the radioactivity change of a liquid or solid phase in a closed solid-liquid system is described. (auth)

26457 DIRECT LABELING OF ORGANIC SUBSTANCES BY NUCLEAR REACTIONS. Naomichi Furukawa (Osaka City Univ.). Genshiryoku Kogyo, 10: No. 7, 49-55(July 1964). (In Japanese)

The direct labeling (recoil labeling) of organic substances with ^{14}C produced by the reaction $^{14}N(n,p)^{14}C$ is described. The recoiled ^{14}C atoms expelled from the initial chemical bond (^{14}N) have a very high energy, of about 45000 ev and lose their energy by Rutherford and hard sphere scatterings (in about 10 Å flight down to about 100 ev). The mechanisms of the eventual chemical bondings are not well known. High density of nitrogen atoms in the initial substance, high neutron flux, and long irradiation are necessary in order to obtain high-specific-activity products. A quartz ampoule with no boron is desirable to avoid a high radioactive contamination. The products usually include reentry, synthesis, and fragmentation products. One or two weeks of standing after irradiation is necessary to remove the contamination. The purification and separation of the labeled compounds is tedious work. The carrier method is effective in the isolation of the synthesis product, but the adsorption method or the gas-chromatograph-counter current system must be used for other cases. The specific radioactivities of the labeled compounds were measured with a gas-flow G-M counter, gas proportional counter, and liquid scintillation counter. The results showed that the specific radioactivities were low and the conversions were 1-3%. (NSA of Japan)

Separation Processes and Procedures

See also Analytical Procedures.

Refer also to abstract 26764.

26458 (BNWL-53) COMPARISON OF TWO CONDENSER-ABSORBER DESIGNS FOR NITROGEN OXIDE RECOVERY. W. J. Van Slyke (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 13, 1965. Contract AT(45-1)-1830. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The following experimental results were obtained on single-tube downdraft absorber-condensers operating on simulated dissolver off-gas under equivalent cooling water flow and condensing side cross sectional area: (1.) Single-tube downdraft condenser tests indicate that substitution of plain (unfinned) tubes surrounded with Raschig rings for the currently installed longitudinal finned tubes will result in approximately the same mass and heat transfer characteristics. (2.) The packed condenser tests showed that an appreciably higher gas side pressure drop will occur. For example, at 9.0 scfm gas inlet flow, equivalent to 4600 scfm for a plant scale unit, the differential pressure was negligible for the externally finned system, and 6.0 pounds per square inch for the externally packed plain tube test. (auth)

26459 (CEA-R-2700) LES LABORATOIRES DE FABRICATION DE L'USINE D'EXTRACTION DU PLUTONIUM DE MARCOULE. EXPERIENCE DES 6 PREMIERES ANNEES DE FONCTIONNEMENT, 1957-1963. (The Production Control Laboratories of the Plutonium Extraction Plant at Marcoule, Six Years Operating Experience, 1957-1963). Andre Fontaine (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Oct. 1964. 76p. Dep.(mn).

A summary is given of the conditions prevailing, after six years of operation, in the laboratories of the Plutonium Extraction Plant. The origins and objectives are briefly reviewed, the technology and staff recruitment policy are examined, and progress made is shown. The methods used as well as the scope of application and limits imposed at the present state are considered. Past achievements and future possibilities are examined. An attempt has been made to bring out the outlook for the more distant future and to investigate the conditions required for the successful carrying out of the program. (auth)

26460 (CEA-R-2773) UTILISATION D'UNE COLONNE ECHANGEUSE D'IONS A LIT MOBILE POUR LA PURIFICATION DU PLUTONIUM. (Use of a Moving-Bed Ion-Exchange Column for Plutonium Purification). Jean Sabatier (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre de Études Nucléaires). Mar. 1965. 23p. Dep.(mn).

When large amounts of fissile matter have to be purified on ion exchange resins, it is difficult to use a fixed bed because of its limiting maximum size. With a moving bed it is possible to ensure a continuous production which can easily be integrated into a purification line on account of its large production capacity. The installation described is derived from an American prototype designed for uranium separation. As a result of many modifications, it is suitable for the purification of plutonium and several such columns will shortly be operating in various French centers. The moving bed column, which has a diameter of 25 mm, was first tried with the uranium-thorium mixture and then, after modifications, on the plutonium-uranium mixture. The production capacity will depend on the plutonium concentration which can be tolerated in the effluents. It is possible to treat 150 g/day of plutonium alone; the effluents obtained have a concentration of around 1 mg/l. The plutonium-uranium separation is improved by a 5 N acidic rinsing as well as by a temperature increase. The decontamination factor increased from 14 to 7 N nitric acid solution to 115 in 5 N nitric acid solution. A temperature increase of about 20°C leads to a decontamination factor of over 500. This result is sufficiently encouraging for the possibility of failure installations operating in optimum temperature conditions, i.e., 60-65°C, to be considered. (auth)

26461 (HW-56210) AN ANALYSIS OF REDOX SAND FILTER DATA. C. E. Davis (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). May 29, 1958. Contract AT(45-1)-1350. 12p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

An investigation was made on the activity levels in the 291-S Sand Filter from 1953 to 1958, to determine the cause of the increase from 1 to 44 C/day in Nov. 1957. An extensive spread of contamination in H Cell by the failure of an H-4 Oxidizer vessel was the primary cause of the activity increase. The activity has now decreased to near normal, and the filter life does not appear to be impaired. No significant emission through the filter was observed. (D.L.C.)

26462 (HW-84509) PURIFICATION OF MERCURY BY COUNTERCURRENT LIQUID-LIQUID EXTRACTION. D. A. Cochran (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 16, 1964. Contract AT (45-1)-1350. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Countercurrent liquid-liquid extractions have been successfully used for the rapid separation of high purity products. This concept was used to devise a method for purifying mercury. The method described is a method for cleaning large amounts of mercury in a short period of time. Mercury is washed in a counterflow column with a nitric acid-mercuric nitrate solution to remove contaminants. This results in mercury with a quality higher than redistilled mercury and considerably better than commercially purchased mercury. (auth)

26463 (IDO-14630) REMOVAL OF TRIBUTYL PHOSPHATE AND ITS DEGRADATION PRODUCTS FROM ACIDIFIED URANYL NITRATE SOLUTIONS. H. T. Hahn, E. M. Vander Wall, R. H. Ray, and R. G. Butzman (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Aug. 1964. Contract AT(10-1)-205. 32p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The behavior of tributyl phosphate and its degradation product, dibutyl phosphate, in plant streams during solvent extraction reprocessing of enriched uranium was studied in detail by analysis of plant samples from operations at the Idaho Chemical Processing Plant. Distribution and kinetic data for the extraction of unwanted tributyl phosphate from aqueous process streams were obtained for the design of a solvent extraction contactor intended for this

purpose. Laboratory and pilot plant data have demonstrated effective removal of undesirable dibutyl phosphate from aqueous process streams by sorption on hydrous zirconium oxide. The zirconium oxide can be regenerated with sodium hydroxide and used for many cycles. It can be dissolved in warm eight-molar nitric acid for final disposal. (auth)

26464 (NIJS-R-427) EFFECT OF THE REAGENT STRUCTURE ON THE EXTRACTION OF URANIUM(VI) WITH DIFFERENT PHOSPHORIC ACID ESTERS. F. Krasovec and C. Klofutar (Nuklearni Institut "Jozef Stefan," Ljubljana (Yugoslavia)). Apr. 1964. 10p. Dep. (mn).

The extraction of uranium(VI) from 1N $HClO_4$–$NaClO_4$ aqueous phase with chloroform solution of five phosphoric acid esters HDXP was investigated, where X represents phenyl, p-tolyl, benzyl, p-chlorophenyl, and β-naphthyl substituent. The data demonstrate the presence of the complex $UO_2A_2(HA)_2$ in the organic phase. Two alternative reactions describing the extraction process are given and their overall equilibrium constants K_3 and K_5 calculated. Using the obtained data, an empirical equation was derived correlating log K_5 with the characteristic, i.e. acid dissociation, distribution and dimerization, constants of the corresponding reagent. This equation enables one to predict extraction ability of any phosphoric acid ester if its characteristic constants are known. The results also show that a change of the reagent structure, leading to a higher acid dissociation and distribution constant and simultaneously to a lower dimerization constant, will improve extraction ability of the resulting phosphoric acid ester. (auth)

26465 (ORNL-TM-1097) TRU DISCONNECT FERRULE AND CLAMP DETAILS. O. O. Yarbro (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 41p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

A complete set is presented of disconnect clamp and ferrule drawings of the types to be used in the Transuranium Processing Plant. Included are designs for connections in stainless steel, Hastelloy C, tantalum, and Zircaloy-2 for tubing sizes of ¼, ⅜-, ½-, and ¾-inch OD and pipe sizes of ¼, ⅜, and ½ inch. (auth)

26466 (RFP-115) EXTRACTION OF URANIUM FROM INCINERATOR ASH LEACH SOLUTIONS. J. C. Biery (Rocky Flats Plant, Dow Chemical Co., Denver, Colo.). July 10, 1958. Contract AT(29-1)-1106. 93p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The purpose of this investigation was to find liquid extraction agents which would efficiently remove uranium from HNO_3, HCl, H_2SO_4, and H_3PO_4 incinerator ash leach solutions. The following solvents were tested. The diluent for each solvent was kerosene. 1) Di-2-ethylhexylphosphoric acid plus dihexylhexylphosphonate (D2EHPA–DHHP). 2) Di-2-ethylhexylphosphoric acid plus trioctylphosphine oxide (D2EHPA–TOPO). 3) Mono-heptadecylphosphoric acid (HDPA). 4) Triisooctylamine. 5) 9D-178 amine (Rohm and Haas). The extraction feed solutions were prepared by leaching incinerator ashes. These solutions contained up to 5 M of H^+ and 7 M of anions. Of the solvents tested, the mixture of 0.5 M D2EHPA plus 0.08 M TOPO gave the highest distribution coefficients and the best extraction characteristics. The 0.5 M D2EHPA plus 0.103 M DHHP was also a very acceptable solvent. Data for the backwashing of uranium from these solvents are also presented. The solvents, D2EHPA-DHHP, D2EHPA-TOPO, HDPA, and amines were successfully backwashed with Na_2CO_3 solutions, HCl, and water respectively. (auth)

26467 (TID-21796) RADIOISOTOPE REMOVAL FROM MILK. Final Report, June 1, 1963–November 30, 1964. B. van't Riet (Virginia Univ., Charlottesville). Contract AT(40-1)-3117. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A method was developed for the rapid and accurate determination of traces of Sr in materials of high Ca content. The method uses a combination of commercially available resins, buffers, and chelating agents for the separation of Sr and Ca. Good results were obtained in solutions of $CaCl_2$, sea water, tap water, bone ash, clam shells, and dolomite. Possible applications of the method in the removal of ^{85}Sr from milk are discussed. Studies indicated that the method will be useful in reducing mild contamination of milk by fallout, or can be used for the neutralization of acidified milk in conjunction with the Beltsville method of milk decontamination. (C.H.)

26468 REPROCESSING OF NUCLEAR REACTOR FUELS BY PROCESSES BASED ON VOLATILIZATION FRACTIONAL DISTILLATION, AND SELECTIVE ADSORPTION. A. A. Jonke (Argonne National Lab., Ill.). At. Energy Rev., 3: 3-60(1965).

Although the reprocessing of irradiated fuels was accomplished successfully for many years by solvent extraction processes, other reprocessing methods, which do not depend on organic solvents and aqueous media, appear to have some important economic advantages. One such reprocessing method depends upon conversion of fuel materials to volatile compounds, such as uranium hexafluoride and plutonium hexafluoride. Fractional distillation and/or adsorption techniques are employed to accomplish the necessary high degree of separation of uranium and plutonium from fission products and other constituents of the spent fuel. Processes based on volatilization methods are under development for application to a variety of nuclear fuels of both the low-enrichment type and the high-enrichment type. Several head-end procedures for accomplishing the halogenation reactions necessary for the preparation of volatile compounds were investigated in various pilot plants, some of which were operated with fully irradiated fuel elements. Head-end procedures employing gaseous reagents and fluidized-bed reaction equipment have, in recent months, also received major attention in United States and European laboratories. In the concept of the fluidized-bed fluoride volatility process under development, fuel elements or bundles are immersed in fluidized solid media, and reacted with gaseous reagents to remove the cladding and to convert uranium and plutonium to the volatile hexafluorides. The latter compounds are then decontaminated, separated, and converted to final products for recycle to nuclear reactors. The status of development is approaching a point at which a full-scale reprocessing plant could be designed for some types of fully-enriched uranium fuels, which do not contain plutonium in recoverable amounts. For plutonium-containing fuels, additional development work may be required. Pilot plants for development and demonstration of the fluidized-bed process with irradiated fuel elements are under design or construction in the United States, France, and Belgium. (auth)

26469 THE WET PROCESSING OF IRRADIATED FUEL ELEMENTS. C. J. Joseph. Atoomenergie Haar Toepassingen, 6: 273-83(Dec. 1964). (In Dutch)

The various steps of wet processes decladding and dissolution, decontamination, separation, concentrating, and purification, are described. Some engineering aspects of a processing plant are discussed. (tr-auth)

26470 THE EXTRACTIONAL BEHAVIOR OF CERIUM WITH ACETYLACETONE. Shohachiro Oki (Tohoku Univ., Sendai). Bull. Chem. Soc. Japan, 38: 522-6(Apr. 1965).

The extraction behavior of trace amounts of ^{144}Ce with acetylacetone was studied. The distribution ratio of acetylacetone between benzene and a 0.1M sodium perchlorate solution was constant in the pH range 1.5 to 7, and the distribution coefficients were determined to be 5.5, 5.4, and 5.3 at 10, 25, and 40°C, respectively. The distribution ratio of cerium was shown to be proportional to the fourth power of the concentration of the acetylacetonate ions and to the square of that of acetylacetone in the organic phase. From these results, it was concluded that cerium exists as a tetravalent ion in the system and that the chemical form of cerium extracted in the organic phase is $CeA_4 \cdot 2HA$ (A is acetate ion). Two molecules of acetylacetone are assumed to combine with CeA_4 forming hydrogen bonds. (auth)

26471 SEPARATION OF ZINC-65 BY THE DITHIZONE–CHLOROFORM EXTRACTION. Nasumi Ishiwatari (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 14: 305-9(Apr. 1965). (In Japanese)

A method using dithizone-chloroform extraction for separating ^{65}Zn from aqueous solutions containing ^{51}Cr, ^{54}Mn, ^{59}Fe, ^{60}Co, ^{65}Zn, and $^{110\,m}Ag$ is described. After addition of Ag carrier to about 1.8N H_2SO_4 solution of the sample containing the six nuclides, $^{110\,m}Ag$ was separated by duplicate dithizone-chloroform extractions. Then sodium citrate was added to the aqueous solution, and the pH of the solution was adjusted to 6 to 7 with sodium hydroxide. After the extraction of ^{65}Zn and ^{60}Co into the organic phase with dithizone-chloroform, ^{65}Zn alone was back-extracted into 0.2N HCl solution by washing the organic phase. Using the method, ^{65}Zn was isolated from the aqueous solution containing the six nuclides and the recovery was about 100%. (auth)

26472 4,5,6,7-TETRAHYDROINDAZOL-3-ONE CARBOXYLIC ACIDS. IV. ACID DISSOCIATION CONSTANTS AND COMPLEX FORMATION WITH CALCIUM, STRONTIUM AND BARIUM. V. Skaric, V. Turjak-Zebic, M. Branica, and D. Skaric (Inst. "Ruder Boskovic," Zagreb). Croat. Chem. Acta, 36: 221-31(1964).

The dissociation constants of 2-phenyl-4,5,6,7-tetrahydroindazol-3-one-5,5-dicarboxylic acid (FIDA) and its stability constants with alkaline earth ions are reported. FIDA was first tested for toxicity. In connection with the determination and the interpretation of pK values of tetrahydroindazolone carboxylic acids and their ethyl esters, the potentiometric titration procedure is described. The same procedure and apparatus were used for the potentiometric titration in the presence of metals. FIDA was shown to be an excellent reagent for the separation of barium from strontium. (auth)

26473 CESIUM-137, BY-PRODUCT OF THE REPROCESSING OF IRRADIATED FUELS AND ENERGY SOURCES. Baldomero Lopez Perez (JEN, Madrid). Energia Nucl. (Madrid), 8: No. 32: 52-9(Oct.-Dec. 1964). (In Spanish)

The recovery and purification of ^{137}Cs by crystallization with ammonium aluminum sulfate and solvent extraction with phenols were investigated. The cesium carbonate obtained from the crystallization process contained traces of Al, Fe, Ni, and Ru. Sources prepared by dissolution of the carbonate with HCl, evaporation, and calcination at 300°C had an activity of 26 C/g. The solvent extraction method using 4-sec-butyl-2-(α-methylbenzyl)-phenol appeared to be the most promising with a yield of 99.5%. (J.S.R.)

26474 THE MERCURY-CATALYZED SULFURIC ACID DISSOLUTION OF ALUMINUM AND S.A.P. G. Beone (CNEN. Rome). Energia Nucl. (Milan), 12: 273-9(May 1965).

A method is proposed for the dissolution of aluminum and S.A.P. which utilizes sulfuric acid catalyzed by mercuric sulfate. The dissolution rate increases with increasing sulfuric acid concentration up to about 6M for aluminum and up to about 3M for S.A.P. 930. The dissolution rate depends also on the mercury sulfate concentration. A minimum of 25, 300, and 450% stoichiometric excess of acid is required for a reasonable rate dissolution of aluminum, S.A.P. 960, and S.A.P. 930, respectively. The metal dissolution rate decreases with increasing contents of Al_2O_3 in S.A.P. (auth)

26475 REFINING OF DOMESTIC URANIUM ORES. Hideo Kinoshita (Furukawa Electric Co., Ltd., Japan). FAPIG (Tokyo), No. 32, 106-10(June 1964). (In Japanese)

The method developed and described in the paper is as follows: digestion of the uranium ore in $NaHCO_3$ solution at 100°C; extraction of the uranium by Amberlite La-2 from the 0.1M H_2SO_4 solution; back extraction; reduction and fluorination of the uranium in the presence of SO_2, HCOOH, and NH_4F; filtration of precipitated $UF_4 \cdot NH_4F$; thermal decomposition of the $UF_4 \cdot NH_4F$ at 390°C; reduction of the UF_4 to the metallic uranium. The reduction and fluorination processes are described in detail. The reaction proceeds as follows: $UO_2Cl_2 + 2SO_2 + HCOOH + 5NH_4F \rightarrow UF_4 \cdot NH_4F\downarrow + 2NH_4Cl + 2NH_4HSO_3 + CO_2$. The effects of the concentrations of free HCl, uranium, and the reagents added are described. The recovery of uranium by the reaction is calculated. (NSA of Japan)

26476 REACTION OF URANYL NITRATE AND THORIUM NITRATE DURING COMBINED EXTRACTION BY TRIBUTYL PHOSPHATE. A. V. Nikolaev, A. I. Ryabinin, and Yu. A. Afanas'ev (Inst. of Inorganic Chemistry, Siberian Academy of Sciences, Novosbirsk). Izv. Akad. Nauk SSSR, Ser. Khim., No. 11, 60-2(1964). (In Russian)

The behavior of $UO_2(NO_3)_2$ and $Th(NO_3)_4$ in a five-component extraction system $UO_2(NO_3)_2 - Th(NO_3)_4 - 1.5$ M$HNO_3 - H_2O$ - TBP at 25 ± 0.1°C was analyzed. The extraction of ~5 mole $Th(NO_3)_4$ was strongly inhibited by the presence of $UO_2(NO_3)_2$. However, reactions with low concentrations (~ 0.15 mole/l) of $UO_2(NO_3)_2$ and increased concentrations of $Th(NO_3)_4$ resulted in reduced solubility constants for $UO_2(NO_3)_2$. It is shown that while uranyl nitrate is capable of forcing out thorium nitrate from an organic phase into an aqueous phase, thorium nitrates also can force out small concentrations of $UO_2(NO_3)_2$ from the organic phase. The coefficients of the nitric acid across the phase diagram were constant (0.15 to 0.20) and separation coefficients for uranyl and thorium nitrates ranged from 10 to 20. (R.V.J.)

26477 URANYL NITRATE EXTRACTION BY PYRIDINE-N-OXIDE DERIVATIVES. V. G. Torgov, A. V. Nikolaev, V. A. Mikhailov (Inst. of Inorganic Chemistry, Siberian Academy of Sciences, Novosibirsk). Izv. Akad. Nauk SSSR, Ser. Khim., No. 11, 95-104(1964). (In Russian)

Nine complexes of uranyl nitrate were synthesized with pyridine-N-oxide derivatives. Extraction of $UO_2(NO_3)_2$ by a series of α-alkyl pyridine-N-oxides was investigated and equilibrium constants for uranyl nitrate extraction by α-alkyl pyridine-N-oxides in C_6H_6, CCl_4, and $CHCl_3$ were determined. It is shown that for $UO_2(NO_3)_2$ the α-alkyl pyridine-N-oxides in medium acid solutions are more efficient extracting agents than TBP. (R.V.J.)

26478 SORPTION PROPERTIES OF IONIC PRECIPITATES AND HYDRATED OXIDES UTILIZED IN THE SORPTION OF P^{32}, S^{35}, AND I^{131} FROM AQUEOUS SOLUTIONS. Frantisek Kepak (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 11: 125-8(1965). (In Czech)

The sorption of phosphate, sulfate, iodide, and iodate ions on ionic precipitates and insoluble metal hydroxides or hydrated oxides is reviewed. The mechanism of sorption on the two types of sorbents is considered. The results indicated that the ionic precipitates and hydrated oxides may guarantee an effective sorption of ^{32}P, ^{35}S, and ^{131}I in the form of phosphate, sulfate, iodide, and iodate anions from aqueous solutions. (auth)

26479 CHLORINATION OF NINGYO-TOGE URANIUM ORES BY THE MOVING BED. Shiro Ino and Shigeki Toyama (Government Chemical Industrial Research Inst., Tokyo). Kagaku Kogaku, 28: 607-13(July 1964). (In Japanese)

Investigations were made on the chlorination of Ningyo-Toge uranium ores by the moving bed. Reaction equations showing the chlorination rate of each component were written. An experimental plant (1-2 kg ore/hour) was constructed and the possibility of continuous operation of the chlorination was confirmed. At high concentrations of Cl_2, there was a large difference between the calculated and experimental data; however, at low concentrations of Cl_2, the difference was small. The approximate heat reaction was calculated from the axial temperature distribution in the chlorinator. (NSA of Japan)

26480 CHROMATOGRAPHIC SEPARATION OF CERIUM FROM MANGANESE AND SOME OTHER METALS. R. N. Golovatyi, and V. V. Oshchapovskii. Ukr. Khim. Zh., 31: 310-13(1965). (In Russian)

The behavior of the ions cerium, manganese, copper, nickel, calcium, and magnesium in chromatographic experiments in chromatograms conventionally processed with ammonium acetate buffered mixtures, with 10% solutions of pyridine, and with NaOH and NH_4OH solutions in the presence of hydrogen peroxide was investigated. It was established that cerium was converted into the non-ion exchange form. Copper and nickel partially converted into the non-ion exchange form by treatment with alkali,

ammonia, or pyridine. The remaining cations did not lose their capacity for exchange in cation salt solutions. It is shown that cerium by hydrolytic fixation with the help of ammonium acetate buffered solutions at pH 6.2 + H_2O_2 on cationite KU-2 is satisfactorily separated from magnesium, copper, nickel, calcium, and manganese. The separation of cerium and manganese in alloys by application of chromatographic separation of these metals is discussed. (tr-auth)

ENGINEERING

General

26481 (AD-608518) FEASIBILITY STUDY OF SHOCK ISOLATING A VERY LARGE STRUCTURE. J. P. Den Hartog, David E. Newland, and John F. Flory (Massachusetts Inst. of Tech., Cambridge and New Mexico Univ., Albuquerque). Sept. 1964. Contract AF29(601)-6002 107p. (AFWL-TDR-64-20). $4.00(CFSTI).

The problem of suspending a very large structure within an underground cavity so as to provide adequate shock isolation is considered. The geometry necessary to uncouple the modes of vibration of a simple system is studied, and recommendations are made concerning the relation between base and side springs. Coil-spring suspension systems are investigated and general design equations and charts are presented. Pneumatic suspension is considered. A new type of pneumatic suspension consisting of corrugated metal bellows is proposed and design equations and charts for such a system are presented. Liquid suspension is briefly discussed. Transient waves in various shock isolation systems are studied. It is concluded that pneumatic suspension systems employing corrugated metal bellows hold much promise and should be further investigated. Shock isolation of a very large structure appears to be feasible using either coil-spring or pneumatic-bellows supports. (auth)

26482 (SC-DC-65-1305) A STUDY OF IMPACT EFFECTS OF SPHERICAL SHELLS. Quarterly Progress Report No. 5, November 1, 1964–January 31, 1965. Charles E. Stoneking (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). For Sandia Corp., Albuquerque, N. Mex. Contract [AT(29-1)-789]. 32p. Dep. (mn); $2.00(cy), 1(mn) CFSTI.

A program is described to investigate the structural integrity of hollow spheres by impact against rigid targets. Program results are to be used in establishment of equations relating rupture velocity and variable test parameters. Work completed includes facility construction, installation and calibration of equipment, personnel training, and test specimen design and procurement. Theoretical studies on the response of cylinders and spheres to impact loads are summarized, and the impact pressure measuring system is described. (J.R.D.)

26483 (SCL-DR-65-28) DYNAMIC BUCKLING OF AN ELASTICALLY SUPPORTED THIN CYLINDRICAL SHELL UNDER DYNAMIC AXIAL LOAD AND LATERAL PRESSURE. C. W. Robinson, Jr. (Sandia Corp., Livermore, Calif.). Apr. 1965. Contract AT(29-1)-789. 29p. Dep. (mn); $2.00(cy), 1(mn) CFSTI.

The nonlinear response and the stability of an elastically supported cylindrical shell under a time-dependent dynamic radial pressure and a dynamic axial load is analyzed. In the analysis, the Lagrange equations are applied to an assumed displacement shape, and the Donnell equations are used to determine the membrane stresses. A pair of differential equations is derived. The results are compared with accepted static buckling theories, and the results for one shell under dynamic load are presented. (auth)

26484 (UCRL-13119) A STUDY OF WATER WAVES PRODUCED BY IMPACT LOADS ON UNCONFINED GROUND WATER AQUIFERS. Daniel K. Sunada and David K. Todd (California Univ., Berkeley. Hydraulic Lab.). June 30, 1964. Contract AT(11-1)-34. 42p. Dep. (mn); $2.00(cy), 1(mn) CFSTI.

A model study was made of water waves produced by an impulse load in an unconfined ground water aquifer. Boundary conditions of dimensions of the spherical load area, initial groundwater depths, and impact loads were studied. A wedge-shaped porous media model of plexiglas was employed for the flow tests. Glass spheres served as the media with deaired water as the fluid. Impulse pressures were recorded by a Sanborn recorder and the development of the wave photographed by a 35-mm motion picture camera. Wave heights for various dimensions of the prototype condition are presented graphically in model values so that with the proper selection of scale laws, various prototype conditions can be evaluated. In addition, model scale laws were developed to be applicable for turbulent as well as laminar flow conditions. Model results indicated that for a set displacement of volume of fluid and moderate impulse pressures, wave heights are primarily a function of the physical dimensions of the load area. At low impulse pressures, gravity plays an important role in partially dissipating the wave as it is being formed. Further analysis indicated that the base time of the impulse pressure essentially governs the time required for the wave to develop. (auth)

26485 CALCULATIONS FOR A MAGNETIC CIRCUIT OF A HEXAPOLAR PERMANENT-MAGNET LENS. C. Audoin (Institut d'Electronique, Orsay, France). J. Phys., Phys. Appl. (Paris), 26: 71A-6A(Feb. 1965). (In French)

With the aid of a given simplifying hypothesis, simple analytic expressions are derived, which serve as a guide in designing a six-pole permanent magnet lens. In the expressions obtained, the magnetic flux densities are referred to that at the apex of the pole-piece, and the shape of the poles is described by dimensionless parameters. Two practical examples are given. The results obtained are in good agreement with the calculations. (auth)

Applications of Nuclear Explosions

26486 (PNE-609F) DEEP UNDERGROUND SHOCK MEASUREMENTS. J. D. Day (Army Engineer Waterways Experiment Station, Vicksburg, Miss. Nuclear Weapons Effects Div.). Dec. 1964. Project DUGOUT. 54p. Dep.; $3.00(cy), 2(mn) CFSTI.

The objectives of the study were to study the underground transmission of shock from a row-charge cratering detonation and to evaluate the effect of such a detonation on adjacent charge emplacement holes. The experimental layout consisted of ten 36-inch-diameter holes, drilled to a depth of approximately 64 feet in basalt on Buckboard Mesa at the Nevada Test Site. These holes were drilled on 45-foot centers on an east-west line; the five easternmost holes were shot holes and the remaining holes were instrument holes. The five shot holes had a mined spherical cavity (approximately 10 feet in diameter) at the bottom with the center of the cavity at a depth of approximately 59 feet. These cavities were filled with a liquid charge, nitromethane. The instrument holes contained particle velocity gages and accelerometers; the diameters of these holes were measured before and after the shot in order to assess damage thereto. The results of the gage measurements showed that the two instrument holes nearest the detonation were stressed beyond their elastic limits whereas the remaining three instrument holes survived and could have been used for later charge emplacement. (auth)

26487 DISTRIBUTION OF EJECTA FROM CRATERING EXPLOSIONS IN SOILS. R. H. Carlson and G. D. Jones (Boeing Co., Seattle). J. Geophys. Res., 70: 1897-1910 (Apr. 15, 1965).

A study of the deposition of ejecta from two nuclear and five chemical cratering events in alluvial mediums indicates that 80% of the ejected material is deposited within a radial distance of 5.5 crater radii and 50% of the total ejected material is distributed within 2 crater radii. The ratio of total ejected mass to the missing mass as represented by the apparent crater averaged 0.53 for nuclear craters and 0.74 for chemical craters, charge burst depth having little or no effect. Two cratering devices (one nuclear and the

other chemical) detonated at the same scaled burst depth but differing in energy release by over two orders of magnitude exhibited mass distributions of ejecta relative to their respective craters which were almost identical. The ratio of true lip mass to missing mass is inversely proportional to the scaled burst depth, ranging from 0.03 at depth to more than 0.25 near the surface for both chemical and nuclear charges. The part of the apparent crater due to compaction of the material surrounding the crater appears to be directly proportional to scaled burst depth, but the absolute value of this quantity is less for chemical shots than for nuclear shots. (auth)

Facilities and Equipment

Refer also to abstracts 26465 and 27744.

26488 (AD-610579) MODEL SOLENOID FOR SUPERCONDUCTING MAGNET. Bruno Zotter and Arthur Wachtenheim (Army Electronics Labs., Fort Monmouth, N. J.). Nov. 1964. 19p. (ECOM-2532). $1.00(CFSTI).

A replica of the five-section solenoid to be used in a superconducting magnet for investigation of ultra-low-noise traveling-wave tubes (TWT's) was constructed. Several field configurations were achieved which are required for the TWT experiments, i.e., straight field; step field, with and without zero; and center peaked field. A traveling probe was constructed which can be utilized for the model solenoid as well as for the active superconducting magnet. (auth)

26489 (AECL-2242) EFFECT OF SEAL RING DEFLECTION ON THE CHARACTERISTICS OF FACE-TYPE MECHANICAL SHAFT SEALS IN HIGH PRESSURE WATER. R. D. Watson (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1963. 18p. Dep.; $1.00(AECL).

The effect of seal ring deflection on the characteristics of face-type seals was investigated by assuming that the seal rings deflected in the following ways: the deflection varied uniformly across the face or the deflection at any point across the seal face was proportional to the pressure at that point. Theoretical curves were developed, which show the variation in balance ratio and leak-rate with film thickness for different deflections of the seal ring. The effects of seal ring size and fluid viscosity on the seal characteristics were also considered. Symmetrical deflection of the rings of a face-type mechanical shaft seal is necessary to provide stability. To be useful the deflection must allow a wedge of water to form between the faces. Seals with absolutely flat and parallel faces are unstable. Wear and erosion are believed to be partly responsible for seal failure since they produce an out-of-balance condition, which in turn leads to overheating and more wear. (auth)

26490 (GEAP-4847) RADIAL VANE STEAM SEPARATOR DEVELOPMENT. Quarterly Report No. 3, January–March 1965. R. H. Moen (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1965. Work Performed under United States–Euratom Joint Research and development Program. Contract AT(04-3)-189. 84p. (EURAEC-1365). Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Further analyses of the data obtained last quarter were carried out, more data on water-layer thickness and velocity using eighteen 6-inch nozzles were obtained, an experiment to determine the effect of operating with vanes shortened below the nozzles was carried out, the two-vane adjustable test unit was tested in the Steam-Water Test Facility at Moss Landing, and an attempt was made to analyze and predict carryover between the vanes: Two new model separators were designed, drawn up, and sent out for bid. The clear plastic two-vane unit was designed, drawn up, and sent out for bid. A vendor was selected, and the order for this unit was placed. The design for the Large Air-Water Test Facility modification was completed, requests for bids were sent out, and a low bidder was accepted. (auth)

26491 (LAMS-2983(Suppl.)) SUPPLEMENTAL IMPACT TESTS ON ICC 6-J AND ICC 2-R CONTAINER (B.E. 1736). Horace E. Noyes (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Apr. 9, 1965. Contract W-7405-eng-36. 18p. Dep.; $1.00(cy), 1(mn) CFSTI.

Drop tests were conducted on a standard ICC 6-J steel drum with steel rod spacers, vermiculite cushioning, and a 6-in. dia steel pipe section which was loaded with lead bricks to give 104 and 156 lb net weight. The results proved the integrity of the package. Less denting of the drum resulted when a $\frac{3}{8}$-in. bolt was used in place of the $\frac{5}{8}$-in. bolt closure. (D.L.C.)

26492 (NRL-6205) THE DESIGN, CONSTRUCTION, AND EQUIPMENT OF A NEW HIGH-LEVEL RADIATION LABORATORY AT NRL. E. J. Chapin (Naval Research Lab., Washington, D. C.). Apr. 14, 1965. 121p. $2.75 (CFSTI).

A new NRL High Level Radiation Laboratory is described, with special emphasis on the design, construction, and collateral equipment. This laboratory provides a means for safely handling and conducting research on gamma-active materials of interest to the Navy. The facility includes: five hot cells with three designed for 1000 curies and two designed for 10,000 curies of 1-Mev gamma; isolation cubicles back of cells; a "warm" work area; a decontamination room; x-ray laboratory; radiochemistry laboratory; machine shop; isotope storage facilities; waste disposal system; "cold" laboratories; and offices and utilities area. Design innovations discussed include: steel-lined cells; all-glass windows with exceptional viewing angle and clarity; manually operated hinged steel shielding doors; internal and external transfer drawers; special receptacle panels in cells; cell lighting; underwall U-tubes; underwindow access ports; removable roof plugs; isotope storage; waste disposal system; and gas scrubber. Equipment discussed includes: heavy-duty master-slave manipulators; mechanical arm manipulators and bridge cranes in cells; through-the-wall periscope; through-the-wall stereomicroscope; a remotely controlled shielded metallograph with through-the-wall specimen transporter; and metallographic specimen preparation equipment. Results of tests with a 9500-Curie ^{60}Co source on the shielding integrity of the facility are presented. (auth)

26493 (JPRS-29075(p.122-35)) A DISTRIBUTED COUPLER FOR A FAST CYCLOTRON WAVE. A. S. Roshal' and V. S. Popov. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 903-13(Sept.-Oct. 1964).

The frequency characteristics and magnitude of the matching band for a travelling cyclotron wave coupler for electron-beam parametric amplifiers are studied. It is shown that the coupler has broad-band characteristics only when the equivalent line possesses the proper dispersion. The presence of line losses impairs the signal-to-noise ratio at the output of the coupler. The matching band is understood to be the range of frequencies in which not less than half of the input power of the signal is converted to electron flux, while the noise elimination band is taken to be the frequency range in which input noise of the flux is reduced to a set level which is specified for particular cases. The coupler is presented in the form of an equivalent line. It is assumed that the field created by the line is linearly polarized, that space charge is absent, and that the beam is infinitely thin. (auth)

26494 HITACHI SERVO-MANIPULATOR WITH THE ALL-TRANSISTORIZED CONTROL SYSTEM. Keizo Wase and Kiyoshi Miyazawa (Hitachi, Ltd., Tokyo). Hitachi Hyoron, 46: 950-4(June 1964). (In Japanese)

A new manipulator for radioactive substances was developed by Hitachi, Ltd., in which an all-transistorized control system is used. The manipulator is capable of manipulation of radioactive substances over 10^4 curies; the conventional mechanical manipulators can handle less than 10^3 curies. Seven motions are possible for the tongs connected to the arms and hands. The leader system operated by the manipulator operator is connected through the bilateral servomechanism for high fidelity to the follower system, which includes the tongs, etc. The bilateral

servomechanism also serves as the sensor of the leader system and feels well the manipulation force effected at the follower. (NSA of Japan)

26495 RE-VAMPING AND SOURCE RESTORATION OF THE 1000 CURIE COBALT-60 IRRADIATION FACILITY. Yohta Nakai and Koji Matsuda (Japanese Assn. for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunski Kenkyu Kyokai Nempo, 5: 19-25(Nov. 1964). (In Japanese)

As a result of about 6 years operation, the 1000-curie cobalt-60 irradiation facility needed drastic overhauling and replacement of the irradiating source. The cobalt-60 source was replaced by a 1200 C cobalt source imported from Canada. This source has a specific activity of 23 C/g, consists of 6 stainless-steel, double capsules (outer diameter 6 mm, length 200 mm). The bearing for the rotating shutter in the source container was changed to a frictionless type bearing with molybdenum disulfide as the lubricant. No other major mechanical faults were found, and no significant contamination from the corrosion of the cobalt capsules was detected at the time of overhauling. (auth)

26496 Sr^{90} BETA IRRADIATOR IS COMPACT, INEXPENSIVE. N. A. Krohn (Oak Ridge National Lab., Tenn.). Nucleonics, 23: No. 5, 83; 86(May 1965).

An irradiation facility is described in which an 80-C, disk-shaped source of $SrTiO_3$ is used. The results of dope rate measurements by several different methods are included. (D.C.W.)

26497 MACHINE FOR SEPARATING IRRADIATED FUEL SLUGS FROM THEIR JACKETS. Pierre Dabernard and Rene Guilloteau (to Commissariat a l'Energie Atomique). U. S. Patent 3,173,320. Mar. 16, 1965. Priority date June 13, 1960, France.

An apparatus for separating an irradiated nuclear fuel slug from its rigid cylindrical jacket is intended to reduce the number of operations and movements required. The slug is positioned adjacent and in line with a separator member provided with a hole of cross section identical to that of the slug. Cutting tools are arranged to cut the jacket along two longitudinal lines while the slug is held in this position. The slug is then pushed through the hole to separate slug from jacket. (A.G.W.)

Heat Transfer and Fluid Flow

See also PHYSICS — General.

Refer also to abstracts 26921, 27735, and 27795.

26498 (AE-177) BURNOUT DATA FOR FLOW OF BOILING WATER IN VERTICAL ROUND DUCTS, ANNULI AND ROD CLUSTERS. K. M. Becker, G. Hernborg, M. Bode, and O. Eriksson (Aktiebolaget Atomenergi, Stockholm (Sweden)). Mar. 1965. 108p. Dep.(mn).

Tables are presented of the burnout data obtained for flow in vertical channels at the Heat Engineering Laboratory of AB Atomenergi in Sweden. The data covers measurements in round ducts, annuli, and 3-rod and 7-rod clusters. (auth)

26499 (LA-3144) NUMERICAL FLUID DYNAMICS USING THE PARTICLE-AND-FORCE METHOD. PART I. THE METHOD AND ITS APPLICATIONS. Bart J. Daly, Francis H. Harlow, and James E. Welch. Appendixes B, C, and D by Edward N. Wilson. PART II. SOME BASIC PROPERTIES OF PARTICLE DYNAMICS. Francis H. Harlow and Everett E. Sanmann (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Sept. 1964. Contract [W-7405-eng-36]. 164p. Dep.; $5.00(cy), 3(mn) CFSTI.

Since its original proposal in 1961, the Particle-and-Force (PAF) method for numerical fluid dynamic studies has been improved considerably and tested in a variety of new circumstances. This report, consisting of two parts, discusses at length a number of properties of the method from conceptual, practical, and experimental points of view. Part I is directly concerned with the methodology, giving in detail the procedure as it is now applied. It also includes the results of experimental calculations, the conclusions, and a discussion of extensions now being developed. Part II delves more deeply into the meaning of the particle representation of fluid dynamics through a close examination of some pertinent idealized computer experiments. (auth)

26500 (NYO-3304-4) INVESTIGATION OF BOILING FLOW REGIMES AND CRITICAL HEAT FLUX. Report No. 552. Quarterly Progress Report, December 15, 1964–March 15, 1965. A. E. Bergles, E. G. Doyle, L. G. Clawson, M. Suo, W. M. Rohsenow, and J. G. Bourne (Dynatech Corp., Cambridge, Mass.). Apr. 1, 1965. Contract AT-(30-1)-3304. 24p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Completed and anticipated modifications to the experimental facility are described. Recent experimental results for flow regimes in an 8-ft 0.4-in. i.d. test section at 500 psia are discussed in detail. (auth)

26501 (TID-21846) USAEC/AECL COOPERATIVE PROGRAM ON HEAVY WATER MODERATED POWER REACTORS. SECOND EXPERIMENTAL STUDY OF DRYOUT IN A LONG VERTICAL TUBE WITH A COSINE HEAT FLUX. Topical Report No. 5. J. E. Casterline (Columbia Univ., New York. Engineering Research Labs.). Feb. 26, 1965. Contract AT(30-3)-187. 52p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

An experimental investigation was conducted on dryout heat flux in an internally cooled tube with an axial cosine distribution of heat flux. The tube ID was 0.400 in. and the heated length was 16 feet. The test pressure was 1000 psia. Coolant flow was vertically upward. The results were compared with those obtained using a heater having a uniform axial heat flux. The local conditions at dryout in the cosine tube were equal to, or lower than, those in the uniform tube, on a quality versus heat flux basis. At low mass velocity, the cosine heater sustained a higher power for the same coolant inlet conditions. Above a mass velocity of 3×10^6 lb/hr-ft^2, this advantage was lost. Regions of pressure fluctuation were observed. (auth)

26502 STUDY OF THE HEAT TRANSFER AND CHARGE LOSSES IN A MAGNETOHYDRODYNAMIC FLOW. Christian Rioux and Gilbert Sultan (Faculte des Sciences, Orsay, France). Compt. Rend., 260: 1855-7(Feb. 15, 1965). (In French)

The apparatus studied makes it possible to measure the transfer of heat using a metallic electric-conductor block between two liquid-metal jets in counter-current turbulent flow. This assembly is introduced in a magnetic field with variable orientation. (tr-auth)

26503 MAGNETOHYDRODYNAMIC FLOW IN RECTANGULAR DUCTS. J. C. R. Hunt (Central Electricity Research Labs., Leatherhead, Eng.). J. Fluid Mech., 21: 577-90(Apr. 1965).

An analysis is presented of laminar motion of a conducting liquid in a rectangular duct under a uniform transverse magnetic field. The effects of conducting walls are investigated. Exact solutions are obtained for two cases; perfectly conducting walls perpendicular to the field and thin walls of arbitrary conductivity parallel to the field, and non-conducting walls parallel to the field and thin walls of arbitrary conductivity perpendicular to the field. The boundary layers on the walls parallel to the field are studied in the first case; and it is found that at high Hartmann number (M), large positive and negative velocities of order MV_c are induced, where V_c is the velocity of the core. It is suggested that contrary to previous assumptions the magnetic field may in some cases have a destabilizing effect on flow in ducts. (auth)

26504 NUMERICAL TECHNIQUES FOR BOILING FLOW STABILITY ANALYSES. J. E. Meyer (Westinghouse Electric Corp., Pittsburgh) and E. A. Reinhard. J. Heat Transfer, 87: 311-12(May 1965). (WAPD-T-1587)

Approximations to mass, momentum, and energy equations are required for finite difference analyses of transient two-phase flow through a heated channel. The truncation error for mass and energy approximations can be reduced by use of the numerical techniques described. These im-

provements are considered especially important in the study of boiling flow oscillation phenomena. (auth)

26505 HEAT TRANSFER TO MERCURY FLOWING IN-LINE THROUGH A ROD BUNDLE. Bruce Nimmo (Brookhaven National Lab., Upton, N. Y.) and Orrington E. Dwyer. J. Heat Transfer, 87: 312-13(May 1965). (BNL-7476)

Data are presented on heat transfer to mercury flowing in-line through an unbaffled bundle of circular rods. The tests were made to document more fully the "dog-leg" shape of Nusselt number versus Peclet number curves. (M.C.G.)

26506 INTEGRAL ANALYSIS OF THE FLOW OF A HEAT-GENERATING FLUID IN THE ENTRANCE REGION OF A PARALLEL-PLATE CHANNEL. J. L. Novotny (Univ. of Minnesota, Minneapolis) and E. R. G. Eckert. J. Heat Transfer, 87: 313-14(May 1965).

Analyses were made to predict laminar forced-convection heat transfer in a parallel-plate channel with heat sources uniformly distributed in the fluid. They were based on the application of the Kármán-Pohlhausen method to the simultaneous thermal and hydrodynamic development region of a channel with constant wall temperature where the heat-generating fluid had a uniform entrance temperature. (M.C.G.)

26507 HEAT TRANSFER AND FLOW INSTABILITY IN THE FORCED-CIRCULATION BOILER TUBES. Hiroshi Muto (Japan Atomic Industrial Forum, Inc.). Karyoku Hatsuden, No. 89, 92-111(Feb. 1964). (In Japanese)

The behavior of steam-water two-phase flow at high temperature and high pressure is one of the important problems to be investigated in connection with the boilers of forced-circulation boiling-water reactors. Several aspects of the problem are described, namely, the flow instability, the burnout, the dynamic behavior of the two-phase flow, the flow patterns, the pressure drop, etc. The theoretical and experimental results obtained by many workers are summarized, including the occurrence of flow instability, two types of instability, i.e., the flow excursion and flow oscillation, the relationship between the instability and burnout, the conditions for the occurrence of instability, instability in the parallel tubes, and the instability caused by the circulation pumps. (About 50 references) (NSA of Japan)

26508 ON SOME BASIC PROBLEMS IN THE APPLICATION OF MAGNETOHYDRODYNAMICS TO GEOPHYSICS. P. Mauersberger. Monatsber. Deut. Akad. Wiss. Berlin, 6: 866-70(1964). (In German)

Certain basic questions are discussed which arise when magnetohydrodynamics is applied in geophysical sciences. First, the form of the fundamental equations of MHD in the case of accelerated motion of matter within a reference system which itself is in accelerated motion is considered. The hydrodynamic and the electrodynamic components of the system of equations are treated separately. Second, the representation is considered of physically observed conditions by a meaningful system of differential equations, equations of state, initial and boundary conditions. This question pertains to the study of such phenomena as eddy diffusion and circulation. In conclusion, there is the feasibility of applying the HAMILTON principle or a corresponding variation principle which leads to the HAMILTON-JACOBI theory (a theory in which no linearity of equations is assumed). (CFSTI)

26509 SOME PECULIARITIES OF THE INFLUENCE OF A TRANSVERSE MAGNETIC FIELD ON THE TURBULENT FLOW OF A LIQUID METAL AT VARIOUS REYNOLDS NUMBERS. G. G. Branover and O. A. Livelausis (Inst. of Physics, Academy of Sciences, Latvian SSR). Zh. Tekhn. Fiz., 35: 235-41(Feb. 1965). (In Russian)

The flow of mercury in a transverse magnetic field was investigated experimentally. The investigation was undertaken in part because of the contrary dependences of flow resistance on the magnetic field, found at low Reynolds numbers by Hartman and at high Reynolds numbers by Mergatroyd and by Brouillette and Lykodes. The intermediate range of Reynolds numbers was covered by the present experiments, and it was found that when Reynolds number was 2160 the flow resistance was independent of the magnetic field in the region of turbulent flow. In all cases laminar flow set in at the critical Reynolds number $250M^2\tanh M/(M-\tanh M)$, where M is Hartman's number and is proportional to the magnetic field. The difference between the magnetic field dependence of the flow resistance in turbulent flow at high and low Reynolds numbers is ascribed to the different relative importance of the Hartman effect (flattening of the velocity profile) and the magnetic suppression of turbulence in the two regions. The existence of the Hartman effect was verified directly by velocity profile measurements with a modified Pitot tube. The flow resistance was measured at Reynolds numbers from 6680 to 14,900 in smooth and rough channels, and it is concluded that the flow resistance is given with engineering accuracy by $L_0(1 + fM^2/R)$, where L_0 is the flow resistance at zero field, R is Reynolds number, and f is 2 for smooth walls and of the order 10 for very rough walls. Experiments concerning the behavior of the flow in a channel of which the width changes suddenly are discussed briefly. (ATD)

26510 MODELS OF CONVECTIVE PROCESSES IN LIQUID METALS IN THE PRESENCE OF MAGNETIC FIELDS. A. E. Mikel'son. p.101-14 of "Voprosy Magnitnoi Gidrodinamiki. IV." Riga, Publishing House of Latvian SSR, 1964. (In Russian)

The MHD equations are presented for heat flow in a liquid metal flowing in an electromagnetic field. If interest is confined to the heat flux between the liquid metal and its containing wall (where there are no electric fields), the equations can be simplified to equations in dimensionless numbers. Temperatures were measured with chromel-alumel thermocouples on a 15 cm diameter sphere of 1 mm thick stainless steel which contained either mercury or liquid sodium; an electric heater was in the center of the sphere. The outer surface of the sphere was cooled by forced air. An inductor with 80 windings surrounded the sphere and air channel. Placing a current of 67 amps on the inductor increased the heat conduction of mercury by a factor of 2 to 3. Less effect was seen with sodium since its thermal conductivity is 7 times that of mercury. Curves are given for the effects of changing other parameters of the experiment. Using a 3-phase inductor instead of a single-phase inductor increased the mercury velocity at the wall of the sphere by a factor of over 10. (TTT)

26511 MHD TURBULENT SHEAR FLOW IN WEAKLY CONDUCTING FLUIDS. Albert L. Loeffler, Jr. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). 15p. (CONF-641119).

From American Physical Society, Division of Fluid Dynamics, Pasadena, Calif.

The effect of a transverse magnetic field on a high Reynolds number flow of a weakly conducting incompressible fluid is studied theoretically. The flow occurs between two electrically insulated infinite parallel plates, and is assumed to be fully developed. A small perturbation technique is employed. Under the previously mentioned conditions of very large values of inertial to magnetic forces, the effects of the magnetic field on the turbulent fluctuations (the inertial terms in the equation) can be neglected compared to the effects on the mean flow. The total mean velocity (ordinary turbulent plus perturbation) is calculated and plotted against Hartmann number; the results appear reasonable for Hartmann numbers up to about four. Hartmann number is here based on the channel half-width. The increase over the ordinary turbulent value of the friction factor is shown to be proportional to M^2/Re, where M is the Hartmann number and Re the Reynolds number. Comparison is made with available experimental data. The agreement is reasonably good for values of M^2/Re up to about 4×10^{-4}. It is expected that better agreement would be obtained with higher Reynolds number data. (auth)

26512 HEAT-EXCHANGER. Joens Arthur Dahlgren. British Patent 984,199. Feb. 24, 1965. Filed Apr. 16, 1963.

A heat exchanger is designed for use as steam generator

for a water-cooled nuclear reactor. The heat exchanger includes two parallel tube plates with a set of Field tubes secured to each tube plate. A first heat exchanging fluid is supplied to the space between the tube plates so as to flow around the Field tubes; a second heat exchanging fluid is supplied to the interior of the Field tubes. Supports are provided to connect the tube plates, and baffle plates in the space between the tube plates direct the fluid flow in that space. (A.G.W.)

26513 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS. Alan Denys Wellington Corbet and Frederick Samuel Dickinson (United Kingdom Atomic Energy Authority). British Patent 984,719. Mar. 3, 1965. Filed Mar. 13, 1962.

In a tube bundle for a heat exchanger comprising a cluster of spaced parallel tubes end-supported by tube plates, the tube plates are assembled in spaced relationship by the tubes the ends of which are secured to nonflanged ends of flanged ferrules. The flanges of the ferrules are joined to the tube plates. Alternatively, rectilinearly flanged ferrules may be joined to the ends of the tubes and then joined together at the flanges to form a lattice-jointed structure that is joined to a tube plate. (A.G.W.)

Materials Testing

26514 (DP-950) NONDESTRUCTIVE TEST OF CARBON BEDS FOR REACTOR CONTAINMENT APPLICATIONS. Progress Report, July–September 1964. David R. Muhlbaier (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr. 1965. Contract AT (07-2)-1. 15p. Dep.; $1.00(cy), 1(mn) CFSTI.

A standardized nondestructive and generally applicable test for installed carbon beds in reactor containment facilities is being developed by the Savannah River Laboratory. Continuing tests show that the permissible ranges of air velocity and H_2O content of the carbon can be extended to encompass the desired test conditions for installed beds of new carbon. The major improvement reported is that of substituting "F-112" or "F-113" for "F-12"—a more volatile "Freon" used in an earlier testing method. (auth)

26515 (NP-14992) THE NONDESTRUCTIVE TESTING OF FUEL ELEMENTS BY MEANS OF COMPTON RECOIL SPECTROMETRY. Semiannual Progress Report. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). Aug. 4, 1964. IAEA Contract 180/R1/RB. 9p. Dep.(mn).

Progress is reported in the construction of a Compton recoil spectrometer for use in nondestructive testing of fuel elements. A new design for a collimator, with about 4° γ-beam divergence, is described. A more efficient use of the detectors has resulted from the new design. (W.L.G.)

26516 THERMAL-NEUTRON RADIOGRAPHY. Kazuyuki Ogawa (Tokyo Shibaura Electric Co., Ltd.). Genshiryoku Kogyo, 10: No. 9, 27-32(Sept. 1964). (In Japanese)

Compared with the usual x-ray radiography, thermal-neutron radiography has the advantage that the thermal neutron reaction with a hydrogen atom is employed in the penetration inspection of various structures. The present investigation was performed in an attempt to find a practical technique, using the TOSHIBA TTR-1 training reactor (swimming-pool type with average thermal output 30 kw and max. 100 kw). The thermal neutron beam (2.5×10^5 n/cm^2 sec at 30 kw) used was obtained using a thermal column of the reactor, a paraffin collimator, and a lead metal filter (5 cm in thickness) to remove the γ rays. Because of the insensitivity of the usual photographic materials to the thermal neutrons, a converter material, which emits photographically detectable radiation on neutron bombardment, was used. Some different techniques for detecting the thermal neutron image are discussed. In the direct-exposure method, the converter screen (Cd foil, $^{113}Cd(n,\gamma)^{114}Cd$) and the photographic film are exposed together to the neutron image; the rapidest used a ZnS(Ag) fluorescent screen containing ^{10}B or ^{6}Li. In the transfer method, only the xrreen (^{115}In, 0.5 mm) is exposed to the neutron image. The resulting radioactive image is transferred by the usual autoradiographic method. The advantage of the latter method over the former is that the interference of the γ rays from the neutron-bombarded specimen is easily eliminated. Several examples of the neutron radiographs taken are presented. (NSA of Japan)

26517 RADIOGRAPHIC APPARATUS. Harry Jackson (to United Kingdom Atomic Energy Authority). British Patent 984,863. Mar. 3, 1965. Filed Nov. 19, 1962.

The radiographic apparatus described consists of a truncated pyramidal funnel of shielding material and a clamp fitting arranged to embrace in conjunction with the funnel an object to be radiographed. The clamp fitting is preferably hinged to the large end of the funnel and adapted to hold a radiographic film. The preferred shielding material is Pb formed as a lining on sheet steel. The specific embodiment shown is adapted to hold an object of circular cross section such as a rod or tube. (A.G.W.)

Protective Structures

26518 (KAPL-M-6446) THE DESIGN OF BARRICADES FOR HAZARDOUS PRESSURE SYSTEMS. C. V. Moore (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 5, 1965. Contract W-31-109-eng-52. 46p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Procedures are given for the rational design of barricades for hazardous pressure systems. Methods are given for estimating the initial velocities of missiles produced by exploding pressure vessels, and for determining the penetrating effects of these missiles on materials normally used for barricade construction. Methods are also given for estimating effective blast pressures produced by the explosion of pressure vessels. Charts and diagrams to assist in performance of the calculations are included. Some checks of the design methods against experimental data are presented. (auth)

26519 (URS-639-9) EFFECTS OF FIRE ON STRUCTURAL DEBRIS PRODUCED BY NUCLEAR BLAST. Research Report. J. Rotz, J. E. Edmunds, and K. Kaplan (URS Corp., Burlingame, Calif.). Jan. 1965. Contract OCD-PS-64-19. 121p.

A study was conducted to evaluate fire effects on debris produced by nuclear weapons. The magnitude of fire from nuclear weapons as a major agent of destruction is discussed. The aftermath of blast and fire is then evaluated in terms of debris. Fire effects on specific types of structures are discussed with respect to determination of resulting changes in debris quantities. Data from major fires are used to augment this portion of the study. The percent of debris vs overpressure curves (developed in the first phase of the program to predict the amount of debris formed by air blast) are altered to reflect the coupled effects of blast and fire. An example employing data, techniques, and knowledge developed in the program is presented. This takes the form of determination of debris depths along a route through a stricken city. (auth)

Space Propulsion

See also REACTOR TECHNOLOGY — Propulsion and Space.

26520 (AD-607817) THE ROLE OF ELECTRON ATTACHMENT IN A ROCKET EXHAUST. Jerry H. Buss (Space Technology Labs., Inc., Los Angeles, Calif.). Feb. 1, 1961. 16p. (STL/TM-61-0000-19011). $1.00 (CFSTI).

Numerous investigations have shown that a large number of free electrons are presented in a rocket exhaust. Because these electrons interfere with telemetry they have been the subject of several studies ranging in motive from discovering their source to inhibiting their production. The puzzling feature of the problem has been the failure of thermodynamics to predict the measured concentration of

free electrons in the exhaust. One theory which has been capable of explaining this anomaly in part treats the impurities in the fuel (notably sodium and potassium) rather than the fuel itself as the source of these electrons. New fuels, which have recently been tested, have been found to have a concentration of free electrons which can not be predicted by the simple impurity ionization theory outlined above. This fact has caused a re-examination of the impurity theory, and this paper is an account of some calculations which show that there is a plausible explanation for the breakdown of the theory. (CFSTI)

26521 (APL-TDR-64-52(Vol.II)) APPLIED RESEARCH ON CONTACT IONIZATION THRUSTER. VOLUME II. MISSION ANALYSES. Ron S. H. Toms—S. L. Eilenberg, ed. (Electro-Optical Systems, Inc., Pasadena, Calif.). May 1964. Contract AF33(657)-10980. 164p. (AD-601187). $3.00(CFSTI).

Possible applications of ion thrusters were investigated. Approximate methods of calculating performance and first-order space-flight mechanics have general application to a wide variety of low-thrust studies. An exhaustive survey of thrusting modes was performed. Missions using solar-electric power and nuclear-electric power were considered. It was concluded that the most attractive application for solar-electric rockets is the 24-hour satellite. For the nuclear-electric rocket an advanced orbital space station, a group of unmanned probes, and all manned missions beyond the moon are highly competitive. (auth)

26522 (NASA-TN-D-2718) RESULTS FROM SERT I ION ROCKET FLIGHT TEST. Ronald J. Cybulski, Daniel M. Shellhammer, Robert R. Lovell, Edward J. Domino, and Joseph T. Kotnik (National Aeronautics and Space Administration, Cleveland, Ohio, Lewis Research Center). Mar. 1965. 42p. $2.00(CFSTI).

The SERT I (Space Electric Rocket Test) spacecraft was launched on July 20, 1964, from Wallops Island, Virginia. Two ion thrustors were programmed to operate sequentially during the flight. One of these, a contact ion thrustor, could not be started because of a high-voltage electrical short circuit. The other thrustor, which was of the electron-bombardment type, operated as expected for a total of 31 minutes and 16 seconds during the flight. The primary flight objective of confirming neutralization of a high-perveance ion beam was attained. Ion beam thrust was measured with three independent thrust measuring systems. All voltages, currents, and other operating characteristics of the electron-bombardment thrustor were close to the nominal values obtained in vacuum tank tests. Telemetry data indicated no noticeable radio-frequency interference generated by the ion beam. Furthermore, all commands between the ground transmitter and spacecraft were transmitted and executed without interference. (auth)

26523 (NASA-TN-D-2804) A TECHNIQUE FOR OBTAINING PLASMA-SHEATH CONFIGURATIONS AND ION OPTICS FOR AN ELECTRON-BOMBARDMENT ION THRUSTOR. Eugene V. Pawlik, Paul M. Margosian, and John F. Staggs (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1965. 33p. $2.00(CFSTI).

A technique was developed for determining the location of the plasma boundaries and the ion trajectories for the accelerator system of an electron-bombardment ion thrustor. The technique consists of using an electrolytic tank and an analog computer to solve Poisson's equation within the region between the ion-chamber and exhaust-beam plasmas with known initial and final plasma potentials. The boundary of the ion-chamber plasma serves as a virtual emitter from which a specified ion current is extracted. The process of matching the boundary conditions, solving Poisson's equation, and finding the ion trajectories is a convergent iterative procedure. Four two-dimensional cases, representing a range of electrical parameters and ion flows for a fixed accelerator grid geometry, were solved. From these solutions it is possible to predict experimentally observed trends such as the ion current extraction capabilities of the grid system and the impingement current conditions. High direct impingement was found at high ion flow conditions. Charge-exchange ion focusing toward the region between the holes or the downstream accelerator surface is evident in the solutions. In addition to comparing predicted trends with experimental data, the accuracy of the solutions was checked with a digital computer program, where the plasma boundary determined by the analog technique was used as a fixed emitter. A comparison between the two-dimensional solutions and the axisymmetric situation encountered in actual thrustors was obtained through the use of a digital program. (auth)

26524 (R64SD91) SPACE PROPULSION BY PLASMA ACCELERATION TECHNIQUES. David B. Miller (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Dec. 1964. 16p. (AD-609833; CONF-641215-1) $1.00(CFSTI).

From New Research Frontiers in Physical Electronics, Ann Arbor, Mich.

The need for high propellant velocity thrustors for space propulsion is established, and non-thermal electric devices are shown to be capable of filling this need. In addition, a class of electric engines (plasma, or electromagnetic engines) based on the Lorentz interaction ($\vec{J} \times \vec{B}$) are revealed to be potentially able to supply the required high thrust densities. From this survey of the plasma thrustors, it is concluded that the coaxial configurations, pulsed and d-c, with and without Hall current at this time show promise. Since, however, there are indications that efficiencies tend to improve as power is increased, the pulsed mode of operation, which can simultaneously feature high instantaneous power but moderate average power, may be the more advantageous mode. The involvement of Hall currents should also increase thrustor efficiency by reducing electrode losses. (auth)

26525 PHYSICAL ROCKET ENGINES. Marcel Grun. Cesk. Casopis Fys., 15: 207-44(1965). (In Czech)

The possibilities of using physical methods of rocket propulsion were tried in addition to chemical rocket engines. Some rocket engines are described. Greater attention was paid to electric motors, whose development has entered the phase of practical application. Rocket engines using nuclear energy were solved experimentally. Theoretically, the problems of quantum fuels were also worked out. The use of fields of force in the cosmos is only in the stage of discussion. A summary of data published in foreign literature is included. (auth)

Vacuum Engineering

26526 STUDY OF DIFFERENT PUMPING METHODS IN ULTRAHIGH VACUUM SYSTEMS AND ANALYSIS OF RESIDUAL GASES. T. Tom (Ultek Corp., Palo Alto, Calif.). Vide, 19: 449-58(Nov.-Dec. 1964). (In French and English)

The pumping action of a film of titanium freshly deposited by sublimation was studied. It was found that the presence in the system of residual inert gas at a high concentration is the cause of limitation toward low pressures in the region of 10^{-6} torr. By combining the action of the titanium getter film with other pumping methods, such as pumping by absorption, ionic pumping, and cryogenic pumping, improvements could be attained. Pressures from 10^{-8} to 10^{-9} torr were easily attained in 3 or 4 hrs for non-dry systems. The best combination found was that of an ionic pump associated with a getter film deposited on a panel cooled to the temperature of liquid nitrogen. The ionic pump used was the ULTEK standard pump of 400 l/sec. The combination of an ionic pump and a water-cooled getter film and the combination of a getter film and cryopumping at the temperature of liquid nitrogen also gave improved pumping characteristics. The most important residual gas in all cases was water vapor. Its concentration seems to depend uniquely on the previous utilization conditions of the system. In some cases, significant concentrations of hydrogen were also found. Traces of CO_2 and N_2 + CO were also found. In systems not using an ionic pump, traces of Ar, He, and methane were found. (tr-auth)

GEOLOGY AND MINERALOGY

General

Refer also to abstracts 26250, 26252, 26254, 26484, and 26917.

26527 (BNWL-20) THE DENSITY-FLOW REGIME OF FRANKLIN D. ROOSEVELT LAKE. R. T. Jaske (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 15, 1965. Contract AT(45-1)-1830. 30p. Dep.; $2.00(cy), 1(mn) CFSTI.

A correlation of 2-yr data describing the thermal regime of Lake Roosevelt and comparisons with Yih's theoretical work and Debler's laboratory studies shows excellent agreement regarding the position of the interfacial layer between the upper relatively stagnant zone and the region of the primary flow transport. This agreement, however, could easily lead to conclusions regarding the entire flow regime that cannot be supported. Further study of the temperature data and confirmation by velometer shows the location of a second, lower interface that roughly conforms to the one above but showing "waves" of instability. It is apparent that more complex theory will have to account for the variance between dynamic and static equilibrium. The study indicates that information on refined mass transport relations is necessary for heat budget studies. The study also indicates that projects or operational concepts involving storage or release of cool water are made difficult because density currents tend to bypass cooler masses. The dynamic equilibrium prevents the formation of "normal" density currents and, as a result, Lake Roosevelt fills with cool water by displacement from the North without any significant horizontal distribution. (auth)

26528 (VUF-1001) GEOLOGICAL, GEOPHYSICAL, CHEMICAL, AND HYDROLOGICAL INVESTIGATIONS OF THE SAND SPRINGS RANGE, FAIRVIEW VALLEY, AND FOURMILE FLAT, CHURCHILL COUNTY, NEVADA. FINAL REPORT FOR SHOAL EVENT, PROJECT SHADE, VELA UNIFORM PROGRAM. (Nevada Mining Analytical Lab., Reno and Nevada Univ., Reno. Desert Research Inst.). 1964. Project SHOAL. 378p. Dep.; $7.00(cy), 8(mn) CFSTI.

Studies were carried out on the evaluation of the site for the Shoal underground nuclear explosion. These studies included geological, geophysical, and hydrological investigations. Pre- and post-shot geologic mapping results are also included. (D.L.C.)

26529 RARE EARTH ABUNDANCES IN THE STANDARD GRANITE G-1 AND STANDARD DIABASE W-1. David G. Towell, Regina Volfovsky, and John W. Winchester (Massachusetts Inst. of Tech., Cambridge). Geochim. Cosmochim. Acta, 29: 569-72(May 1965).

The lanthanide elements (except Gd and Er) were determined in the standard granite G-1 and standard diabase W-1 by neutron activation and a chemical procedure consisting of pre-irradiation separation of the rare earth group and post-irradiation column chromatography of individual lanthanides using bis(2-ethylhexyl)orthophosphoric acid. The logarithm of abundance, normalized to the corresponding abundance in chondrite meteorites, decreases linearly with Z, for G-1 from $_{57}$La to $_{66}$Dy by an abundance ratio of 35 and for W-1 from $_{57}$La to $_{71}$Lu by a ratio of 3·0. Relative to the trend of normalized abundances for the other lanthanides, Eu is singularly low by a factor of 0·7 in G-1 but is normal in W-1. (auth)

26530 KINK-BANDS: SHOCK DEFORMATION OF BIOTITE RESULTING FROM A NUCLEAR EXPLOSION. David Cummings (Geological Survey, Denver). Science, 148: 950-2(May 14, 1965).

Microscopic examination of granodiorite samples from the shock region around a nuclear explosion revealed sharply folded lens-shaped zones (kink-bands) in the mineral biotite. Fifty percent of these zones are oriented approximately 90° to the direction of shock-wave propagation, but other zones are symmetrically concentrated at shear angles of 50 and 70° to the direction of shock-wave propagation. (auth)

26531 LOW DEUTERIUM CONTENT OF LAKE VANDA, ANTARCTICA. Robert A. Ragotzkie (Univ. of Wisconsin, Madison) and Irving Friedman. Science, 148: 1226-7 (May 28, 1965).

Lake Vanda in Victoria Land, Antarctica, is permanently ice-covered and permanently stratified, with warm, salty water near the bottom. Deuterium analyses of lake water from several levels indicate that the lake has a low deuterium content, and that it is stratified with respect to this isotope. This low deuterium content supports the evidence from the lake's ionic content that the saline layer is not of marine origin, and it indicates that evaporation from the ice surface has taken place. The stratification of the lake with respect to deuterium suggests that the upper and lower layers of water were formed at different times from different sources of glacial melt water. (auth)

Natural Radioactivity and Fallout

Refer also to abstracts 25841, 26253, 26679, and 27125.

26532 (CEX-62.6.3) ARMS-II—ARGUELLO AREA AERORADIOACTIVITY SURVEY. R. B. Guillou (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Dec. 1962. Contract [AT(29-1)-1183]. 22p. Dep.; $1.00 (cy), 1(mn) CFSTI.

An Aerial Radiological Measuring Survey (ARMS) of the Arguello area was made for the Civil Effects Test Operations, between Apr. 5 and Apr. 29, 1962. The survey was part of a nationwide program to measure the present environmental levels of gamma radiation. Approximately 2400 traverse miles were flown, at an altitude of 500 ft above the ground, in the area that consists of the land portion of a 100-mile square which is centered near Point Arguello, Calif. The EG&G ARMS-II instrumentation was used in the survey. The data are presented as aeroradioactivity units, or areas with similar gamma-radiation rates at 500 ft, at two map scales: (1) generalized at about 1:1,000,000 and (2) detailed at 1:250,000. The aeroradioactivity in the area is less than 1400 counts/sec, and in much of the area the radioactivity is less than 800 counts/sec. Aerial measurements of ground radioactivity in the ARMS-II Arguello area were consistent with what was expected, considering the geology of the area. The generally moderate aeroradioactivity in the area can be attributed to the clastic sedimentary rocks and to soils derived from them, which comprise most of the surficial materials in the area. (auth)

26533 (NYO-3364-1) OM INNHOLDET AV CESIUM^{137} I MELK FRA VAREN 1964. (Report About Cesium^{137} in Milk from Spring 1964). Kjell Madshus (Norsk Hydro's Inst. for Cancer Research, Oslo); Aksel Stroemme (Norsk Radiumhospital, Oslo); and Kristian Koren (Statens Radiologisk-Fysiske Laboratorium, Oslo (Norway)). Contract AT(30-1)-3364. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Data are presented on the content of ^{137}Cs in milk samples collected in Norway during the spring of 1964. Results are compared with data from 1962 and 1963. An increase of 110 pC/l from 1963 to 1964 was observed. (C.H.)

26534 (NYO-3364-4) THE CORRELATION BETWEEN THE PRECIPITATION AND THE AMOUNT OF ^{137}Cs IN MILK IN NORWAY. Kjell Madshus (Norsk Hydro's Inst. for Cancer Research, Oslo) and Aksel Stroemme (Norsk Radiumhospital, Oslo). Contract AT(30-1)-3364. 22p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The prevailing winds in Norway blow from the Atlantic towards the east. Along the west coast the peculiar topographical conditions will favor a greater precipitation and also a greater deposition of radioactive fallout than in the eastern part of the country. The precipitation in several districts in Norway has been estimated for three consecutive years (1961, 1962, and 1963) and the concentration of ^{137}Cs in milk from about 90% of the dairies in Norway has been measured during the following spring (1962, 1963, and 1964 respectively). Along the coast, statistically significant correlations between the precipitation one year and the amount of ^{137}Cs in milk the following spring have been demonstrated for three consecutive years. In the eastern part of Norway, there is no such systematic correlation. Neither is any such correlation found between the precipitation during the months when grass for storage is grown (May, June, and July) and the amount of ^{137}Cs in the milk the following spring in any district any year. (auth)

26535 (RRA-T43) GAMMA-RAY ENERGY AND ANGULAR DISTRIBUTIONS ABOVE AN INFINITE FALLOUT FIELD. R. L. French (Radiation Research Associates, Inc., Fort Worth, Tex.). May 1, 1964. Contract DA-49-146-XZ-254. 88p.

Monte Carlo techniques were applied in a detailed study of the gamma radiation environment produced in air three feet above fallout uniformly distributed on a smooth ground surface. The basic computations included the energy and angular distributions of the scattered photon flux above monoenergetic plane isotropic gamma-ray sources for ten different source energies from 0.10 to 3.5 Mev. For each source energy, the flux arriving at the receiver in each of ten energy intervals between 0.04 and 3.5 Mev and eighteen equal receiver angle intervals between 0° (nadir) and 180° (zenith) was calculated. Separate calculations were performed for the uncollided fluxes from the infinite plane isotropic source. In addition to the fluxes, the dose arriving through each ten degree interval of receiver angle was also computed. The results of the monoenergetic calculations were combined to obtain energy and angular distributions of the photon flux from fallout of four different ages, viz. 1.12 hours, 23.8 hours, 4.57 days, and 9.82 days. Comparisons with measured and calculated data, both for actual fallout fields and for simulated infinite plane sources, show agreement. (auth)

26536 (RRA-T45) A COMPARATIVE STUDY OF RADIOACTIVE SOURCE ARRANGEMENTS FOR SIMULATING FALLOUT GAMMA RADIATION FIELDS. R. L. French (Radiation Research Associates, Inc., Fort Worth, Tex.). June 15, 1964. Contract DA-49-146-XZ-254. 96p.

Monte Carlo techniques were used in a study of three basically different approaches to simulating the gamma radiation environment near the air/ground interface due to fallout uniformly distributed on the ground surface. The energy and angular distribution of the photon flux at a receiver 3 feet above the ground due to a ^{60}Co point isotropic source also three feet above the ground and at separation distances of 100 to 800 feet was computed, and the results were found to bear little resemblance to those from a uniform fallout field. Results computed for a receiver position three feet above idealized ^{144}Ce, ^{137}Cs, and ^{60}Co infinite plane sources on the ground indicated good simulation of the angular distribution of the gamma-ray dose and, except for energies greater than 1.25 Mev, reasonable simulation of the energy spectra from fallout. A third source arrangement, called the "compact simulator," was found to simulate the fallout gamma radiation environment equally well. The compact simulator utilizes ^{144}Ce, ^{137}Cs, and ^{60}Co in a finite plane source 60 feet in radius and in an elevated toroidal source which acts as a virtual source for the remainder of the infinite plane. In the compact simulator, an overhead slab of water acts as a reflector to simulate air scattering. (auth)

26537 (SC-RR-64-1793) PROJECT SAND FINAL PROGRAM REPORT. VOLUME I. D. Q. Matejka and W. L. Wood (Sandia Corp., Albuquerque, N. Mex.). Apr. 1965. Contract [AT(29-1)-789]. 57p. Dep.; $3.00(cy), 2(mn) CFSTI.

A summary is presented of all the SAND (Sampling of Aerospace Nuclear Debris) ballistic vehicle firings, and an analysis is given of the first SAND sampler flight test. (auth)

26538 (SC-RR-65-184) FALLOUT REPORT—BETA-GAMMA RADIOACTIVITY IN AIR AT SANDIA LABORATORY, JULY THRU DECEMBER 1964. R. E. Womelsduff (Sandia Corp., Albuquerque, N. Mex.). Apr. 1965. Contract AT(29-1)-789. 11p. Dep.; $1.00(cy), 1(mn) CFSTI.

A report is presented of the gross beta-gamma radioactivity (expressed as micromicrocuries per cubic meter) of air samples collected by the Health Physics Division of the Sandia Laboratory of Sandia Corporation during the second half of 1964. (auth)

26539 CONTRIBUTIONS TO THE STUDY OF THE ISOTOPIC COMPOSITION OF ATMOSPHERIC FALLOUT SAMPLES BY THE ABSORPTION OF THE β RADIATION IN ALUMINUM. Victor Mageru and Gheorghe Maxim ("Petru Poni" Inst. of Chemistry and Physics, Iasi). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 15: 395-405 (1964). (In Rumanian)

The isotopes present in the fallout may be identified on the basis of the energy of the emitted β radiation, as determined by analyzing the curve of absorption in Al. When decomposing the absorption curve into its components, the nonlinear behavior of the components was taken into account. The absorption curve was determined at various thicknesses, up to relatively large values; when such thick Al screens were used, the count rate was controlled by the hardest portion of the spectrum. The decay of the activity as a function of time was also determined in order to obtain supplementary information. The method developed was tested on a mixture of $^{90}Sr-^{90}Y$ radioactive equilibrium. Separate tests were carried out on the soluble and insoluble portions of the mixture. It was concluded that consideration of the nonlinear character allows the absorption curve of an isotopic mixture to be decomposed more precisely into a number of component lines than was possible before. Use of a special coefficient allowed the values of the various components to be weighed. (TTT)

26540 ANALYSIS OF RADIOACTIVE FALLOUT BY PHYSICAL METHODS. Victor Mageru and Gheorghe Maxim. Analele Stiint. Univ. "A. I. Cuza," Iasi, Sect. I, 10: 125-31(1964).

Physical methods, based on the determination of the characteristics of the radiations emitted by the isotopes of the sample, for the analysis of fallout are discussed. (C.E.S.)

26541 MODELS OF THE SINKING OF THE ATMOSPHERIC FALLOUT ON THE SURFACE OF THE EARTH. Vilem Santholzer, Vratislav Havlovic, and Pravoslav Stransky (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Casopis Fys., 15: 193-202(1965). (In Czech)

On the basis of spectroscopic measurements, mean residence times were calculated for the individual nuclides contained in the atmospheric fallout collected in the years 1963 and 1964. The mean residence time of the fission and activation products in this period was about 1 year, which agreed in order with the latest results from other areas. The amount of strontium determined after the radiochemical separation agreed in order with L. Machta's estimation for the northern hemisphere. In 1963 and 1964, the source of atmospheric fallout was only the stratospheric reservoir, therefore simple model conceptions could be used for the deposition of the fallout on the surface of the earth. (auth)

26542 ON THE "MOBILE" FORM OF URANIUM AND THORIUM IN ALKALINE ROCKS AND POSTMAGMATIC FORMATIONS BEING CONNECTED WITH THEM. I. G. Mineeva. Geokhimiya, No. 4, 443-54(Apr. 1965). (In Russian)

The content of uranium and thorium, which can be leached out in various differentiates of potassic alkaline magma and postmagmatic formations connected with it, was determined. It was established that in the differentiation process there is a general increase of radioactive element content toward the end of the process along with increases

in the amount of uranium and thorium being leached out. In basic and alkaline rocks the chief fixation form of uranium and thorium was the accessory or isomorphic form; in granites the mobile form of uranium and thorium acquired a greater significance. In postmagmatic altered alkaline rocks hexavalent uranium was chiefly leached out; this was conditioned by the oxidation of both the uranium and the thorium minerals into which uranium enters. (auth)

26543 REPORT ON RADIOACTIVITY. A. Schwebel (National Bureau of Standards, Washington, D. C.). J. Assoc. Offic. Agr. Chemists, 48: 150(Feb. 1965).

The need for tests to detect short- and long-lived radionuclides and to determine their levels in the biosphere, following the cessation of atmospheric testing of nuclear weapons by the major world powers, is discussed. There should be no further increase in long-lived fission products in the atmosphere. Assuming no further large-scale testing, fallout should decrease, and the amount of ^{90}Sr and ^{137}Cs entering the food supply should level off and begin decreasing slowly. Since the radionuclides will continue to contaminate the food supply for a long time, and since there may be nuclear accidents involving reactors which could contaminate large areas, methods for the detection of long-lived radionuclides are a continuing necessity. It has not been possible to obtain the cooperation of a sufficient number of laboratories to do a collaborative study on the Harley methods for ^{90}Sr (organic solvent extraction procedure) in water, dairy products, feeds, forage, fruits, and vegetables; and on the radiochemical method for ^{137}Cs, with a comparative study between the radiochemical method and γ-ray spectrometric methods. For tracer work employing radionuclides, it is recommended that official methods be developed for the radionuclides ^{3}H, ^{14}C, ^{32}P, and ^{35}S. (BBB)

26544 LEAD ISOTOPES IN FELDSPARS FROM SELECTED GRANITIC ROCKS ASSOCIATED WITH REGIONAL METAMORPHISM. B. R. Doe (Geological Survey, Denver), G. R. Tilton, and C. A. Hopson. J. Geophys. Res., 70: 1947-68(Apr. 15, 1965).

Paleozoic regional metamorphism of Precambrian gneiss near Baltimore, Maryland, altered the lead-isotope ratios in Precambrian feldspars but did not affect the Rb-Sr ages. This fact indicates that the alteration took place without solution and redeposition or melting of the feldspars. The metamorphism of amphibolite facies (kyanite zone) undoubtedly caused the observed differences in the lead-isotope ratios. The Paleozoic metamorphism was of lower grade to the west and had little effect on the isotopic composition of lead in feldspars of the pyroxene-bearing granitic rocks underlying Shenandoah National Park, Virginia. The feldspars of these rocks contain lead of uniform isotopic composition similar to those of younger granites of nearly equivalent age (about 1000 Myr) near Balmat, New York. The isotopic composition of lead in the Paleozoic granitic rocks and pegmatites near Baltimore, Maryland, is less uniform than in the 1000-Myr-old rocks at Shenandoah National Park. Age data and geologic relations suggest thermal effects sufficient to lower biotite ages by 50 to 150 Myr. This heating plus the fact that much older rocks (Precambrian) underlie the region may account for the lack of a unique Appalachian lead through natural contamination. Isotopic uniformity of leads in the feldspars from the Vermilion granite, Minnesota, is comparable to that of the 1000 Myr old granitic rocks at Balmat and Shenandoah National Park. Model lead ages are about 2900 Myr, or approximately 350 Myr greater than biotite K-Ar ages. This relationship is in contrast to the Paleozoic and younger Precambrian granitic rocks of Maryland, Virginia, and New York, for which the model lead ages are less than the biotite K-Ar ages. (auth)

26545 FISSION TRACK DATING OF A MESOLITHIC KNIFE. R. L. Fleischer (General Electric Research Lab., Schenectady, N. Y.), P. B. Price, R. M. Walker, and L. S. B. Leakey. Nature, 205: 1138(Mar. 13, 1965).

The fission track dating method for archeological specimens depends on the fact that most materials contain small quantities of U, which undergoes spontaneous fission, thereby creating damage tracks that are easily revealed by chemical etching. For samples less than about 10^3 years old the age is proportional to the density of tracks and also to the U content, which is found by neutron irradiation of the sample. Dating of objects 20 to 100 yr old is only possible for materials of unusually high U content. Fission track dating methods were used to establish the age of an obsidian mesolithic knife blade from excavations carried out at Gamble's Cave II, Elmenteita. (C.H.)

26546 DISTRIBUTION OF SOME TRACE ELEMENTS AND THE ISOTOPIC COMPOSITION OF STRONTIUM IN HAWAIIAN LAVAS. E. I. Hamilton (Oxford Univ.). Nature, 206: 251-3(Apr. 17, 1965).

Studies were made to determine whether some selected elements together with the isotopic composition of Sr could be used to illustrate the theory that the alkaline basalts are derived from a deeper level in the mantle than those of tholeiitic affinity. Hawaiian basalts were used. A relatively high radioactive mineral, possibly zircon, was observed in a nepheline, melilite basalt and hawaiite from Hawaii. A high U content found in the rocks was not normally associated with oceanic basalts. Variations in the K/Rb ratio were not regarded as being a result of contamination by marine sediments. Apart from the nepheline and melilite basalts, no significant variations in isotopic composition were observed. It was concluded that the results cannot be used to support or deny an origin of the undersaturated lavas of Oahu from a deeper part of the mantle than those of the tholeiite type. (P.C.H.)

26547 ISOTOPIC COMPOSITION OF STRONTIUM IN CARBONATE ROCKS FROM KESHYA AND MKWISI ZAMBIA. J. L. Powell (Oberlin Coll., Ohio). Nature, 206: 288-9(Apr. 17, 1965).

The $^{87}Sr/^{86}Sr$ ratios of both Keshya and Mkwisi intrusive limestones were found by analyses to be distinctly higher than those of accepted carbonatites and distinctly higher than those of the carbonate veindikes that have been analyzed. This difference can be accounted for by a hypothesis of assimilation of a small amount of granitic material by a carbonate magma providing that such magmas can have strontium concentrations as low as 300-400 ppm. It was concluded that the low concentration of Sr in the Keshya and Mkwisi rocks is of more fundamental significance in terms of their classification and origin than their higher $^{87}Sr/^{86}Sr$ ratios. (P.C.H.)

26548 ON THE VERTICAL PROFILES OF SPECIFIC NUCLEAR FISSION-PRODUCT ACTIVITIES OF THE AIR IN THE LOWER TROPOSPHERE. Reinhold Reiter (Fraunhofer-Gesellschaft zur Forderung der Angewandten Forschung, Garmisch, Ger.). Nukleonik, 7: 79-85(Feb. 1965). (In German)

The results of continuous measurements of the long-lived nuclear fission-product activity of aerosols at 3000, 1800, and 700 m NN (at low base distance) are reported. These profile measurements showed that in the advection layer of the troposphere as well as the inversion and exchange layers, an excess of fission products with respect to the ground layer is present only when there is a strong influx of fission products from the stratosphere into the troposphere. If this influx is exhausted then the specific activity of the ground layer is higher than in the advection layer because of the continuing conservation of fission products as a result of the relatively well sealed peplopause. In this specific activity, as a rule, time-isolated maximum values occur. The mean diameter of the particle carrying the fission product was between 0.15 and 0.25 μ in the advection layer; it increased in the ground layer (in exchange and under inversions) to a mean of 0.40 μ. (tr-auth)

26549 STRONTIUM 90 SOURCES IN SOILS OF ARID REGIONS: RAINFALL, DRY FALLOUT, AND IRRIGATION WATER. Milton W. Meyer and Lyle T. Alexander (Soil Survey Lab., Beltsville, Md.). Soil Sci., 99: 234-5(Apr. 1965).

Studies were performed on the Colorado River to determine whether ^{90}Sr in river water used for irrigation reaches the land surface in amounts that are significant when compared with amounts brought down by rainfall and dry fallouts. Samplings at two sites (Yuma and Mohave County,

Arizona) taken between January 1, and December 31, 1961 showed a definite increase in ^{90}Sr added to the soils. However, the amount of ^{90}Sr was small as compared to that of areas having higher rainfall. (H.G.D.)

Techniques and Equipment

Refer also to abstract 26637.

26550 (AD-607946) RESEARCH DIRECTED TOWARD THE USE OF LONG AND INTERMEDIATE PERIOD SEISMIC WAVES FOR THE IDENTIFICATION OF SEISMIC SOURCES. Final Report. L. E. Alsop (Lamont Geological Observatory, Columbia Univ., Palisades, N. Y.). July 31, 1964. Contract AF19(604)-7376. 64p. (AFCRL-64-835). $3.00(CFSTI).

Of particular interest to the needs of Project VELA-UNIFORM are the following: a study of the radiation patterns of surface waves from underground nuclear explosions and small magnitude earthquakes, wherein it was determined that the radiation patterns from explosions in tuff and alluvium, but not in granite, could be interpreted as arising from an explosive force acting as a step function in time; a study of the relative excitation of surface waves by earthquakes and underground explosions, which yielded the result that most but not all of the earthquakes studied generated surface waves 5 to 10 times greater than the maximum observed for explosions of the same Richter magnitude; an almost complete summary of Rayleigh wave phase and group velocities for various regions of the world; a program of epicenter relocation carried out so far for the South Pacific Ocean, the Arctic north of 60° N, the Gulf of Aden, Red Sea, and Arabian Sea, the African Rift Zone, and the Central Indian Ocean, which showed that in these places at least large earthquakes are confined to much smaller regions than previously thought; successful utilization of displacement transducers with long period seismometers. (auth)

26551 (AFCRL-64-666) OCEAN-BOTTOM SEISMOMETER DATA COLLECTION AND ANALYSIS. Final Report. William A. Schneider (Texas Instruments Inc., Dallas. Science Services Div.). Oct. 12, 1964. Contract AF19(604)-8368. 120p. (AD-607785). $4.00(CFSTI).

Ocean-bottom data from three independent geographical locations in the Pacific Ocean were studied for consideration of means of detecting and identification of underground or underwater nuclear explosions. Signal-to-noise ratios on the ocean bottom are generally inferior to those at a land control station by 0 to −10 db in two of the three areas. The superior ocean-bottom (S/N) ratios in the Hawaii area are due principally to a "noisy" land site. The study reveals no consistent differences in phase development between the ocean bottom and land other than effects associated with the free surface and the late arriving T phase. For near regional and local events, the ocean-bottom seismogram often shows greater high frequency energy content than on land. Ocean-bottom magnification of signal energy by as much as 20 db is consistently observed for teleseisms and occassionally for near regional and local events. Ambient noise levels on the ocean bottom are greater than at a land control station by about 20 db at the low frequencies in all three areas. The difference decreases with increasing frequency. (auth)

26552 (NP-14823) ARRAY RESEARCH SEMI-ANNUAL TECHNICAL REPORT NO. 2. Robert Roden, Richard Baldwin, John Burg, Terence Harley, and George T. Baker (Texas Instruments Inc., Dallas. Science Services Div.). Nov. 15, 1964. Contract AF33(657)-12747. 76p.

The performance of horizontal and vertical arrays of seismometers in various configurations is compared theoretically. Ambient noise measurements and array-performance analyses at several seismic stations are reviewed. Correlation functions are derived for non-dispersive seismic wave propagation. A study of intra-array signal equalization is carried out. Analyses are presented of earthquake signals from the Kurile Islands. (T.F.H.)

26553 (UCRL-12327) NUCLEAR DECOUPLING, FULL AND PARTIAL. Dan W. Patterson (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 26, 1965. Contract W-7405-eng-48. 32p. (CONF-650422-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From American Geophysical Union, Program for Section of Seismology Annual Meeting, Washington, D. C.

An underground explosion in a cavity is said to be fully decoupled if the cavity is large enough that the explosion produces only elastic motion in the walls; in a smaller cavity where the wall motion is elastoplastic, the explosion is said to be partially decoupled. The pressure histories on the walls of 5-kt-size and 100-ton-size decoupling cavities in salt are calculated and used to compute the motions of the walls including the effect of elastoplastic behavior of salt. From the motion of the cavity walls, seismic displacement potentials are calculated and compared to the measured close-in displacement potentials for the Salmon event (5 kt) and the Gnome event (3.1 kt scaled to 5 kt), both tamped (tightly coupled) nuclear detonations in salt. The close-in decoupling ratios for salt thus obtained are 350 using Gnome data and 200 using Salmon data. The reduced displacement potential based on the Gnome measurement at 298 m and scated to the 5-kt size of Salmon is found to be 40% above the measured Salmon value at 300 m; the Gnome measurement may have been in the inelastic region or it may have been influenced by stronger horizontal propagation due to bedding planes. Reduced displacement potentials are also calculated for shots of 100 tons, 0.5 kt, and 1 kt, all in a 100-ton-size decoupling cavity. They are 0.45, 5.0, and 45 m^3, respectively, as compared to 145 m^3 for a 100-ton fully tamped shot. (auth)

26554 (VESIAC-4410-48-X) THE GENERATION OF THE PRIMARY SEISMIC SIGNAL BY A CONTAINED EXPLOSION. VESIAC State-of-the-Art Report. Carl Kisslinger (Michigan Univ., Ann Arbor. Acoustics and Seismics Lab.). Apr. 1963. 90p. (AD-403708). $8.60 (CFSTI).

In order to analyze the mechanism by which buried explosions generate seismic waves, the region around the detonation is divided into three zones: (1) a strong-shock (hydrodynamic) zone, (2) a transitional, nonlinear zone, and (3) the elastic region. Experimental equation-of-state data are used in calculating the history of the propagating stress wave, because there is as yet no complete theory of the response of solids to rapidly applied stresses which exceed their yield and crushing strengths. Results indicate that the proper equations of motion are known, as are analytic and numerical methods for solving them. The theory of shock waves in a fluid is applicable to the close-in region, and several failure mechanisms have been postulated for the transition region. The objective of the analysis is the determination of the stress waveform at the inner boundary of elastic behavior. The peak amplitude and spectral content depend on the yield, the type of medium, and the ambient stress (depth of burial). The experimental determination of the shortest range at which elastic behavior begins is difficult in principle, because solutions valid at great distances are not applicable. Experimental determinations of the amplitude-yield relationship must take into account (1) the combined effect of the shift of the spectral peak to lower frequencies as the yield increases and (2) the low-pass filtering properties of the earth. Empirical studies of the effect of the shot-point medium are influenced by the properties of the explosive material. The effect of source depth is difficult to isolate because in most test sites the medium changes with depth. (auth)

26555 (VESIAC-5197VU) GNOME-FISHER BRIEFING. (Air Force Technical Applications Center, Washington, D. C.). Jan. 10, 1962. 12p.

Graphs are presented, most of which plot data for GNOME and FISHER obtained from long-range mobile seismic recording stations. In addition to two maps locating seismic stations for GNOME and FISHER and two graphs giving travel times and amplitude of P-waves from two

earlier shots (BLANCA and LOGAN), the graphs show travel times from FISHER (profile southeast) and GNOME (profile east and northwest; miscellaneous data); P_n amplitude divided by period vs epicentral distance for GNOME and FISHER, using measurements at stations along the profile from Carlsbad, N. M. toward NTS, plus the same kind of data for GNOME alone, with measurements from all stations except those along the Carlsbad-NTS profile; and P_n amplitudes from FISHER and GNOME normalized to amplitude at 1000 km by the inverse cube law. (auth)

26556 (VESIAC-5439VU) PROJECT HARDHAT. Final Report. (Texas Instruments, Inc., Dallas). May 21, 1962. Contract AF33(600)-42411. 90p.

The HARDHAT detonation and recordings were made on February 15, 1962. The primary objective was to record on magnetic tape at least one level of acceptable seismic data on a nuclear event at three separate stations. The objective was attained successfully. Local refraction surveys were made at the three test locations. Station 1, located 10 kilometers from ground zero, recorded no identifiable events beyond the first arrivals from the depth shot. Station 2, located 88.2 kilometers from the shot, recorded several events. There is interpretive evidence of a possible mantle reflection from a depth of ±48 km, as well as reflections and refractions from a discontinuity about 20 km deep. The first part of the record at Station 3, located 136 km from HARDHAT, showed considerable phasing which could be due to Pn and Pg modes arriving at approximately the same time. (auth)

26557 (VESIAC-7724VU) SHALLOW AND DEEP WELLS IN EARTHQUAKE AND EXPLOSION DETECTION. Semi-Annual Technical Report No. 5. Samuel Katz (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Geology). Oct. 21, 1963. Contract AF19(604)-8376. 8p.

A brief discussion is given of progress in research to develop methods for detecting seismic signals by recording water-level fluctuations in open wells and pressure fluctuations in capped wells. (auth)

26558 (VESIAC-7373VU) MODEL STUDIES OF SEISMIC ENERGY DISTRIBUTION AROUND DIFFERENT TYPES OF SOURCE. Final Report. B. F. Howell, Jr., and P. M. Lavin (Pennsylvania State Univ., University Park. Dept. of Geology and Geophysics). Dec. 20, 1963. Contract AF19(604)-7383. 10p. (AFCRL-64-211)

A discussion is presented of model studies of first motions produced by an actual fault. Eight models were used, five constructed of Plexiglas and three of Plexiglas and steel. Results indicated a double-couple source mechanism. Studies were also conducted on the effect of near-source velocity discontinuities on first motion patterns. Conventional two-dimensional ultrasonic techniques were employed. It was shown that it is possible to distinguish between various simple force systems, simulating earthquake and explosion source mechanisms on the basis of first motion studies. However, interpretational problems can exist if the focal area is not homogeneous, as reduced amplitudes and other reflected phases may lead to the first motions being masked on the records. (auth)

26559 (VESIAC-8746VU) MODEL STUDIES OF EXPLOSION-GENERATED SEISMIC WAVES. Semi-annual Technical Report No. 4, April 1–September 30, 1964. (Saint Louis Univ., Mo. Inst. of Tech.). Contract AF19-(628)-1689. 27p.

Research on three aspects of explosion-generated seismic waves was in progress: (1) the pattern of radiation of body waves into the interior of a half-space from a near-surface source; (2) decoupling of seismic energy by shooting in a cavity; and (3) the effect on the characteristics of waves at a distance when the shot is surrounded by a small zone of material with different physical properties than the substance forming the main transmitting medium. (auth)

26560 (VESIAC-9281VU) AN INVESTIGATION OF AUDITORY DISCRIMINATION TECHNIQUES AS APPLIED TO PROJECT VELA UNIFORM. Final Report, October 31, 1963–October 31, 1964. (Bell Telephone Labs., Inc., New York). Dec. 31, 1964. Contract NObsr-91196. 34p.

The results of the listening experiments suggest that at epicentral ranges between 400 and 1200 km, auditory discrimination, with a compression ratio of 400:1, may well be a very useful tool for the Vela Uniform project if the following conditions can be met: 1. A suitable library of known events can be established. 2. High-quality seismograms, free from overloading and high signal-to-noise ratios, are available. (If the first condition can be met, the useful range of the technique may be extended at closer distances.) 3. The distances between the unknown and known events can be closely matched. The measurement of the characteristic of the auditory signals revealed a new measure based on the derivative of the smoothed envelope which appears to be independent of listening results and promises to be useful as a discrimination tool by itself. Although not investigated in detail, pitch changes may provide useful information. (auth)

26561 (WT-1813) SEISMIC EFFECTS FROM A NUCLEAR CRATERING EXPERIMENT IN BASALT. L. M. Lowrie and W. V. Mickey (Coast and Geodetic Survey, Rockville, Md. Washington Science Center). Nov. 1964. Project DANNYBOY. 64p. Dep.; $3.00(cy), 2(mn) (CFSTI).

Project DANNYBOY was a 430-ton nuclear cratering explosion in basalt. Surface earth motions were measured in terms of displacement, velocity, and acceleration at 12 locations from 760 meters to 340 kilometers from surface zero. Multiple regression of maximum earth particle displacements and accelerations from DANNYBOY and four other cratering explosions gave the following expressions: $d_{cm} = 0.6W_{kt}^{0.44}R_{km}^{-1.3}$ for 0.17 km to 27 km, and $a_g = 0.1W_{kt}^{0.29}R_{km}^{-1.7}$ for 0.17 km to 27 km. These equations provide a good fit for data from chemical and nuclear cratering experiments in basalt and alluvium. The applicable yield range is from 20 tons to 100 kilotons, although information from events in basalt is limited to yields of 430 tons or less. The DANNYBOY Event produced about 6.4×10^{16} ergs of source seismic energy, or approximately 0.35 percent of the total available source energy. Calculations for five cratering explosions indicated a decrease in seismic efficiency with increased event yield. (auth)

26562 ON THE ABSOLUTE AGE OF SAXAGAN PLAGIOGRANITES IN THE KRIVOI ROG REGION. A. I. Tugarinov, S. I. Zykov, and S. F. Karpenko. Geokhimiya, No. 2, 245-7(Feb. 1965). (In Russian)

The absolute age of Saxsagan plagiogranites studied by the Pb–U method and by correlation with existing geochronological data was found to be about 3000 to 3100 million years. (R.V.J.)

26563 SIX-YEAR RECORD OF OXYGEN AND HYDROGEN ISOTOPE VARIATIONS IN SOUTH POLE FIRN. Samuel Epstein (California Inst. of Tech., Pasadena), Robert P. Sharp, and Anthony J. Gow. J. Geophys. Res., 70: 1809-14(Apr. 15, 1965).

Direct measurements of snow accumulation at stakes near the South Pole over a 6-year period (1958–1963) were made to check the reliability of accumulation and annual-layer determinations by stratigraphic and isotopic methods. Agreement between interpretations based on stratigraphic and isotopic data is excellent, and both are consistent with accumulation-stake measurements in nearly all respects. All three procedures indicate an average annual accumulation of 7 cm of water at the South Pole over the 1958–1963 interval. Isotope data suggest that depth-hoar formation may result in relative enrichment in ^{18}O. This could come about through partial recondensation of vapor generated within the depth-hoar layer accompanied by escape of residual vapor impoverished in ^{18}O. (auth)

26564 SOME RESULTS ON OXYGEN ISOTOPE STRATIGRAPHY IN THE DEEP DRILLING AT KING BAUDOUIN STATION, ANTARCTICA. Roberto Gonfiantini (CNEN, Pisa, Italy). J. Geophys. Res., 70: 1815-19 (Apr. 15, 1965).

Measured oxygen isotope variations for determining net accumulation rates in three sections of snow and ice core

from a drilling project, at King Baudouin Station on Princesse Ragnhild Coast, Antarctica, are reported and discussed. Results of this investigation show that the 6.10-m surface core section was deposited during 7.5 years, with a yearly mean accumulation of 38.5 cm of water. The intermediate section, from 43.70- to 52.26-m depth, was deposited during 16 to 18 years (depending on interpretation), with a yearly mean accumulation of 41.5 to 36.9 cm of water. The deepest section, from 98.70- to 101.60-m depth, was deposited during 10 years, with a yearly mean accumulation of 24.6 cm of water. The decrease of the mean yearly accumulation measured in the deepest section is probably due to the plastic deformation of the expanding shelf and possibly to a different accumulation rate in the past. The differences among the mean δ values in the three sections are attributed to climatic change and are consistent with the temperature increase observed in Antarctica during the last 60 years. (auth)

26565 Th^{230}/U^{234} AGE OF THE PLEISTOCENE CORALS AND OOLITES OF FLORIDA. J. K. Osmond (Florida State Univ., Tallahassee) J. R. Carpenter, and H. L. Windom. J. Geophys. Res., 70: 1843-7(Apr. 15, 1965).

Determination of the activity ratio $^{230}Th/^{234}U$ in corals from the Pleistocene Key Largo limestone, a fossil coral reef, leads to the conclusion that the reef-forming corals lived about 130,000 years ago in a sea that stood about 10 meters higher than today. Similar ages for the Pleistocene Miami oolite suggest that this formation represents oolitic sand deposited contemporaneously with the coral reef. The age calculation is based on the assumption that living corals extract no thorium from sea water and thus any ^{230}Th found in fossils results from the decay of ^{234}U. Measurements made on recent corals from the same area generally confirm this assumption. (auth)

26566 INVESTIGATION OF THE INFLUENCE OF THE MINERALOGICAL COMPOSITION AND MOISTURE OF SOILS ON THE DETERMINATION OF THEIR VOLUME WEIGHT BY DISPERSED GAMMA-RADIATION METHOD. V. I. Osipov. Vestn. Mosk. Univ., Ser. IV, Geol., No. 2, 61-8(1964). (In Russian)

During the recording of all scattered gamma radiation in soils, the substantial dependence of the speed of calculation on the mineralogical composition and soil moisture was noted. This was explained by the influence of the photoeffect on the soft part of the spectrum from gamma scattering. For elimination of the effect of mineralogical composition and soil moisture on determination of its volume weight by gamma scattering, it is necessary to prevent repeated excitation of the detector by scattered gamma quanta with energies <0.7 to 0.8 Mev. The elimination of much scattered gamma radiation with energies >0.08 Mev from the registered spectrum was undesirable since in this case the sensitivity of the instrument was reduced and the necessity for increasing the activity of the source arises. During the measurement of the volume weight of dispersed soils, the optimum density of the probe is 2.5 to 3.0 g/cm^2. For work in wells, with steel pipes, it is possible to use probes with thin duralumin bodies. (tr-auth)

26567 DEVELOPMENT OF AN ELECTRON BOMBARDMENT FURNACE. UTILIZATION FOR EXTRACTING RADIOGENIC ARGON CONTAINED IN A GLAUCONITE SAMPLE. Donville and Zvenigorosky (Faculte des Sciences, Toulouse). Vide, 19: 443-8(Nov.-Dec. 1964). (In French)

An electronic bombardment furnace was developed to heat under vacuum and to degas the samples studied. The K–Ar absolute age determination method is reviewed, and the principles and advantages of heating by electron bombardment are summarized. The furnace is described, and the experimental technique is given. The furnace operated under a pressure of 10^{-5} torr and the gases released were not resorbed. (J.S.R.)

Thorium and Uranium Minerals

26568 (NYO-10361) AN INVESTIGATION OF THE MINERALOGY, PETROGRAPHY, AND PALEOBOTANY OF URANIUM-BEARING LIGNITES. Final Research Report. T. F. Bates and W. Spackman (Pennsylvania State Univ., University Park. Mineral Industries Experiment Station). May 1, 1965. Contract AT(30-1)-2000. 52p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

A summary is presented of a research program which was conducted to study the uranium complexes in uraniferous lignites, and to develop geological, mineralogical, petrographic, and paleobotanical criteria for locating other sources of uranium. The program covered the following areas: mineralogy of western lignites and related sediments, autoradiography, chemistry and petrography of western lignites and related sediments, palynology of Dakota lignites, and modern phyto-organic sediments and sedimentary environments. (D.L.C.)

HEALTH AND SAFETY

See also BIOLOGY AND MEDICINE — Radiation Hazards and Protection.

Refer also to abstracts 25833, 25868, 25869, 25883, 26276, 26279, 26467, 26491, 26535, 26536, 27782, 27812, and 27814.

26569 (AECL-1239) ANALYSIS OF EXTERNAL RADIATION EXPOSURES IN 1964. G. Cowper and P. C. Rowe (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1965. 17p. Dep.; $0.50(AECL).

An analysis of occupational radiation exposures received by workers at AECL in 1964 was carried out by machine accounting methods. Results are presented in tables and graphs. (auth)

26570 (AERE-M-1469(Rev.)) AN APPLICATION OF THE LOG-NORMAL DISTRIBUTION TO SOME AIR SAMPLING RESULTS AND RECOMMENDATIONS ON THE INTERPRETATION OF AIR SAMPLING DATA. R. F. Hounam (Atomic Energy Research Establishment, Harwell (England)). Mar. 1965. 21p. Dep.; $0.70(BIS); 3s. 6d. (HMSO).

Three recent series of air sampling results are separately analyzed and shown to conform approximately to a log-normal distribution. This finding is followed by a suggestion of how the log-normal distribution may be applied to a series of conforming air sampling results to estimate the hazard to individuals exposed to the same environment. (auth)

26571 (AERE-M-1511) THERMAL TESTS ON AN INSULATED, LARGE-SOURCE, COBALT 60 CONTAINER DESIGN NO. 0063. F. E. Dixon, A. H. Partridge, and A. J. Brook (Atomic Energy Research Establishment, Harwell (England)). Apr. 1965. 29p. Dep.; $0.90(BIS); 4s. 6d. (HMSO).

An account is given of tests made to determine the temperature rise in the ventilated insulating shield of a container Design No. 0063, carrying 105,000 Curies of cobalt-60, and to measure the effect of blocking the ventilation holes as might occur in an accident. It is shown that the ventilated and unventilated thermal shields do not cause over-heating of the container. (auth)

26572 (AERE-M-1512) A STANDARD SERIES OF PACKAGINGS FOR LOADS UP TO 20,000 CURIES OF COBALT 60 OR EQUIVALENT. F. E. Dixon (Atomic Energy Research Establishment, Harwell (England)). Apr. 1965. 10p. Dep.; $0.30(BIS); 1s. 9d. (HMSO).

With the advent of the I.A.E.A. Regulations in 1961, new parameters were set for the design of packaging for radioactive material. A discussion is presented of a comprehensive range built up largely from an existing standard range, but with the addition of those features found necessary to comply with the regulations, and which are described in AERE-R-4810 and T.C.A.P. P64/65, together with an extension of the range to carry up to 20,000 Curies of cobalt-60 or equivalent. This gives a comprehensive range of shielding thicknesses, all of which can be type B approved and some of which are used also as type A packaging. The series caters for a large proportion of the isotope traffic. (auth)

26573 (AHSB(S)R-80) THE FIRE HAZARD OF METALLIC BERYLLIUM. A. Fairbairn (Authority Health and Safety Branch, United Kingdom Atomic Energy Authority, London (England)). 1965. 35p. Dep.

This report relates to the fire which occurred in the extract ventilation filters of the Beryllium Pilot Plant, Imperial Chemical Industries Limited, Metals Division (now Imperial Metal Industries (Kynoch) Ltd.) on the night of 13th/14th September, 1960, and the subsequent Inquiry which included comprehensive tests on the ignition of beryllium metal. Safety principles are given, the application of which will reduce the risk of occurrence of a beryllium metal fire. (auth)

26574 (CEA-R-2707) CONTAMINATION RADIOACTIVE DES DENREES ALIMENTAIRES: DETERMINATION DES NIVEAUX ADMISSIBLES. (Radioactive Contamination of Foodstuffs: Determination of Permissible Levels). Sully Ledermann (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre de Études Nucléaires). Apr. 1965. 41p. (EUR-2177.f). Dep.(mn).

In a latent air-soil contamination situation, the population would receive 80 per cent of its contamination through foodstuffs. The supervision of this food poses many problems: sampling, radionuclide dose measurements, etc. It is also necessary to estimate the maximum permissible concentration of radionuclides in foodstuffs, once the maximum exposure limit for the human body has been fixed. The passage of this level to the maximum concentrations is not simple since each radionuclide has its own particular effect on the body; their concentrations vary from one foodstuff to another; and the average amounts of foodstuffs vary from one population to another. Two methods are given for estimating the maximum permissible concentrations in foodstuffs, together with the diets likely to become critical when several of them are to be considered simultaneously. The results depend on the way in which the present situation can change to become critical. This evolutionary path can only be estimated approximately. Two methods are therefore given for studying the sensitivity of the results. A numerical application of these methods using data actually available is given. The data used are naturally incomplete and this will always be true. This application test indicates however two fields in which an improvement is absolutely necessary. These include multiple observations and simultaneous dosage of at least 2 radionuclides in the same foodstuff, and simultaneous dosage of at least two foodstuffs for the same radionuclide; this assumes a combined effort by the various organisms; and the reaching of an agreement on the dosage methods used by the various organisms, since the results actually available are not comparable. (auth)

26575 (HW-81933) RECYCLED THORIUM DOSE RATES. F. E. Owen (General Electric., Richland, Wash. Hanford Atomic Products Operation). May 15, 1964. Contract AT(45-1)-1350. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The dose rates which one can expect to encounter in handling recycled thorium target elements from the production of ^{233}U are summarized along with the activities of the various dose contributors and how they change with time after processing. The two important sources of radiation dose in thorium are ^{228}Ac and the ^{228}Th daughters. The concentrations of ^{228}Ac and daughters of ^{228}Th in natural thorium are reduced by the recycle process. In recycling thorium, ^{228}Th builds in during the cooling period from the ^{232}U created during irradiation increasing the concentration of ^{228}Th daughters. In producing ^{233}U with 5 ppm ^{232}U from thorium which cools for 270 days and is recycled annually, the thorium will maintain a dose rate very close to that of natural thorium at secular equilibrium. Production of ^{233}U with 1 ppm ^{232}U will reduce the dose rate from thorium by a factor of eight which makes it about equal to natural uranium. At 10 ppm ^{232}U, the dose rate is increased by a factor of three. Thorium-234 would materially increase the dose rate but because of its short half life (24.1 days), it decays to insignificance within the cooling period. Exceptions to this occur when high fluxes are used greater than 5×10^{13} n/cm^2/sec, or when the cooling period is sufficiently less than 270 days. (auth)

26576 (HW-82705) A REVIEW OF THE AIR MONITORING PROGRAM AT THE PRTR. D. McConnon and K. B. Turner (General Electric Co., Richland Wash. Hanford Atomic Products Operation). May 15, 1964. Contract AT(45-1)-1350. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The airborne particulate contamination normally encountered at the PRTR has been identified as ^{88}Rb (18-minute half life) and ^{138}Cs (32.2-minute half life). A calculation method which corrects for radioactive decay during sample collection and after the sample is changed is proposed in place of the present calculation method. Sampling intervals and holding periods of 5 minutes each are recommended for routine use. The present MPC_a in use at the PRTR – 1×10^{-8} $\mu C/cc$ – is judged to be adequate; however, a recommendation is made to use assault mask respiratory protection in place of supplied air masks in atmospheres between 1×10^{-6} $\mu C/cc$ and 1×10^{-5} $\mu C/cc$. (auth)

26577 (INR-568/XIX) LABORATORY CONTROL METHODS OF RADIOACTIVE CONTAMINATION IN WATERS. A. Kostyrko, I. Olszewska, and K. Zarnowiecki (Institute of Nuclear Research, Warsaw (Poland)). Nov. 1964. 22p. Dep.

The three most typical methods for preparing the measurement preparations from aqueous solutions aimed at evaluation of radioactivity losses caused by different chemical operations are investigated. These methods consist in evaporating solutions in beakers or evaporation dishes and subsequent erasing of the precipitate from evaporation dishes, or wiping out of the precipitate from evaporation dishes with wet filter paper and subsequent baking at elevated temperatures. The results show that generally most advantageous is the first of described methods, provided that adequate precautionary measures are preserved. (auth)

26578 (ORNL-NSIC-8) INDEXED BIBLIOGRAPHY OF CURRENT NUCLEAR SAFETY LITERATURE. [PART] 1. (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 147p. Dep.; Free (ORNL)

This bibliography was prepared under the auspices of the Nuclear Safety Information Center. The references include short abstracts and keywords and are sorted into 19 categories, such as siting, radioactive material transportation and handling, space safety, fission products, instrumentation, containment, and radioactive effluents. Keyword and author indexes are included. (D.L.C.)

26579 (RFP-446) EVALUATION AND TREATMENT OF AN ACUTE INTERNAL EXPOSURE TO PLUTONIUM. (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). [Mar. 8, 1965]. Contract AT(29-1)-1106. 29p. (CONF-650302-6). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna.

As a result of an explosion caused by burning plutonium which was accidentally dropped into carbon tetrachloride, an individual was exposed internally to large amounts of plutonium. The skin of his entire body was contaminated to milligram quantities. The tip of the second finger, left hand, was severed. The left thumb had a severe laceration on the anterior surface at the interphalangeal joint, a compound fracture, and dislocation. There were several small lacerations on other fingers and back of the left hand. Small pieces of metal were driven into the hand. Treatment to reduce surface contamination consisted of shaving off hair, including eyebrows, and initial and daily washings of the body with sodium hypochlorite until contamination was reduced to acceptable levels. Evaluations of deposition in the thumb were done by measurement of 17-kev x rays. These evaluations led to the decision to amputate the thumb and finger. The individual was given DTPA treatment within 1 hour after injury and was placed on a subsequent schedule of periodic treatments. Rapid evaluation of plutonium in urine and observations of the effectiveness of DTPA were accomplished by measurement of 17-kev x rays from the raw urine. The limit of detection by this method is 14,200 d/m per 24-hr urine sample. This limit can be extended by an evaporation and dissolution technique to 570 d/m per 24-hr urine sample. Accumulated urine excretion for the first 60 days was 7.3 μC. The individual was counted in the Rocky Flats Body Counter. Counts were made in the liver region, lung region, and left hand following amputation. Using a plastic human phantom for calibration, evaluations of lung and liver deposition were obtained. Evaluation of residual hand deposition was accomplished using a paraffin phantom for calibration and a positioning jig for the hand. Advantages of utilizing each of several available x- and gamma-ray energies were determined. (auth)

26580 (TID-3535(Suppl.1)) RADIOACTIVE DECONTAMINATION. A Literature Search. Henry D. Raleigh, comp. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Apr. 1965. 82p. Dep.; $3.00(cy), 2(mn) CFSTI.

Included are 336 references to unclassified publications on physical and chemical methods for the removal of radioactive contamination. The references cover the period from July 1959 through December 1964. Subject, author, and report number indexes are provided. (auth)

26581 (WT-1176) EFFECTS OF A NUCLEAR EXPLOSION ON TYPICAL NATURAL AND MANUFACTURED GAS UNDERGROUND AND ABOVE-GROUND INSTALLATIONS, INCLUDING APPLIANCES IN HOUSES. Guy Corfield (American Gas Association, Inc., New York and Federal Civil Defense Administration, Battle Creek, Mich.). 54p. Dep.; $3.00(cy), 2(mn) CFSTI.

Typical natural and manufactured gas industry piping, underground and above-ground equipment, and appliances in buildings were installed in accordance with current industry practice at various distances from the base of a 500-ft tower at the top of which was exploded a device with a yield approximately 50% greater than nominal (a nominal atomic bomb has an energy release equivalent to 20 kt of TNT). The distances were selected and the installations were duplicated to produce varying degrees of damage. Underground installations were practically undamaged with the exception that ventilator pipes from a vault at 1470 ft were sheared off at ground level. Service piping, regulators and meters to buildings, and house piping in buildings were undamaged. Appliances in buildings were practically undamaged, and operative, with the exception of those in two houses which were either badly damaged or inaccessible due to collapse of the houses. (auth)

26582 (Y-1401(Rev.)) Y-12 RADIATION SAFETY MANUAL. P. C. McRee, C. M. West, and J. D. McLendon, eds. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Mar. 24, 1965. Contract W-7405-eng-26. 115p. Dep.; $4.00(cy), 2(mn) CFSTI.

Procedures and equipment are described that are used for the protection of personnel from exposure to ionizing radiation and radioactive materials, industrial toxicants, and other environmental factors that may cause sickness, impair health and well-being, or cause inefficiency among plant workers. Radiation protection guides for exposure to external or internal radiation are set out, and criteria for environmental and personnel monitoring programs are presented. Equipment described includes a personnel decontamination facility and whole-body radiation counter. (C.H.)

26583 RADIATION BIOLOGY AND SPACE ENVIRONMENTAL PARAMETERS IN MANNED SPACECRAFT DESIGN AND OPERATIONS. Wright H. Langham (Los Alamos Scientific Lab., N. Mex.), Phillips M. Brooks, and Douglas Grahn, eds. Aerospace Med., 36: 55p.(Feb. 1965). (LA-DC-6827)

A review is presented on the design and operational radiation safety criteria for manned space systems. Information is included on space radiation environment, biological environment, biological effects of radiation, and applications to space flight operations. 286 references are included. (P.C.H.)

26584 VENTILATION FOR BERYLLIUM USERS. PART II. A. J. Breslin (Atomic Energy Commission, New York) and M. S. Weinstein. Air Eng., 6: 38-40(Nov. 1964).

The nature of the beryllium hazard is pointed out. It is less severe in small plants, but still needs careful control. The design of simple but effective ventilation systems is described. The hazard of concern in a small beryllium fabrication facility is respiratory involvement, which may be adequately controlled by maintaining air concentrations below prescribed limits. (P.C.H.)

26585 ACTION LEVELS FOR RADIATION CONTROL AT OAK RIDGE NATIONAL LABORATORY. D. M. Davis (Oak Ridge National Lab., Tenn.). Am. Ind. Hyg. Assoc. J., 26: 165-71(Mar.-Apr. 1965).

The reports of the Federal Radiation Council and the Manual Chapters of the U. S. Atomic Energy Commission present radiation guides and regulations establishing levels that should not be exceeded in normal, or planned, operations. To assure that exposures will not exceed the levels stipulated by the guides and regulations (except in accidents or emergencies), Oak Ridge National Laboratory has established operating levels generally somewhat below the recommended maximum levels. Control measures are initiated when the operating levels are exceeded. The action points and corresponding control measures discussed in this paper are those established and applied at ORNL with proved effectiveness. (auth)

26586 LEVELS OF STRONTIUM-90 IN MILK CONSUMED IN URUGUAY. C. Benech and C. M. Franchi (Instituto de Investigacion de Ciencias Biologicas, Montevideo). Arch. Soc. Biol. Montevideo, 26: 81-6(1963-64). (In Spanish)

Strontium-90 levels in powdered milk for public consumption in Montevideo were determined. The radiochemical separation standard procedure of the U.S. A.E.C. Health and Safety Laboratory was used. The ^{90}Y daughter was counted with a low-background G-M tube calibrated against a U.S. A.E.C. standard sample. Levels from 2.38 ± 0.38 to 2.57 ± 0.28 C of ^{90}Sr/gram of Ca for 1960 and from 1.68 ± 0.18 to 1.86 ± 0.44 C of ^{90}Sr/gram Ca for 1962 were found. The figures were compared with Buenos Aires and Northern Hemisphere values, and their value for prediction of local human bone burden of ^{90}Sr is discussed. (auth)

26587 DETERMINATION OF NATURAL RADIOACTIVE AEROSOLS. F. Behounek (Czech Tech. Univ., Prague and Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Czech. J. Phys., 15: 333-9 (1965).

A critical evaluation is made of methods used for determining natural radioactive aerosols and airborne Rn-222 and Rn-220. From the point of view of health the decisive factor is the amount of active Rn-222 and Rn-220 deposit in inhaled air. A simple filtration method, based on a comparison of the amount of radioactive aerosols in the analyzed air with their content in the free air, i.e. in country air, was elaborated for determining the active deposit. The apparatus is portable and consists of easily accessible parts. (auth)

26588 PREPARATION OF RADIOACTIVE SAMPLES FOR MEASUREMENT. I. PREPARATION OF WATER. D. E. Schmitt. Glas-Instr.-Tech., 7: No. 3, 91-8(1963).

The samples considered were drinking, ground, surface, effluent, and sea-waters, as well as fallout. Since, generally, the direct measurement of the sample is not feasible, the activity must be concentrated. A detailed procedure is given for the concentration of the various types of sample by: direct evaporation with a surface evaporator; co-precipitation with alkaline-earth phosphates, carbonates, or oxalates, or with $Fe(OH_3)$ or $Al(OH)_3$; and ion-exchange. (Public Health Eng. Abstr., 45: (April 1965))

26589 AIR CONTAMINATION BY ACTIVATION OF AIRBORNE DUST DUE TO NEUTRON IRRADIATION. C. Cortissone, O. Ilari, and N. Stipcic (CNEN, Rome). Health Phys., 11: 489-95(June 1965).

The results of an experimental study on the activation of airborne dust exposed to neutron flux densities are reported. The main parameters that can affect the phenomenon (neutron flux density, irradiation time, decay time of the induced activity, dust concentration, and composition) were examined. Dust samples were irradiated in a Triga reactor with a 1.3×10^{12} n/cm^2/sec flux density for periods of 15 sec to 60 min. Concentrations of the activity induced in the air were determined by means of gross beta activity measurements. The radionuclides produced were identified by gamma spectrometry and by decay measurements. The nuclides ^{24}Na, ^{56}Mn, ^{64}Cu, ^{42}K, ^{38}Cl were clearly identified. Traces of ^{99}Mo and ^{31}Si were found; the existence of bromine isotopes was rather doubtful. The values of induced activity ranged from 1×10^{-9} to 4.2×10^{-7} μC/cm^3 of air. To evaluate the inhalation hazard, the measured values were compared with a radioactivity concentration guide. The analysis of the results led to the conclusion that under present conditions the hazard due to inhalation of air containing dusts activated by neutrons is negligible. (auth)

26590 NATURAL RADIOACTIVE AEROSOLS IN THE GROUND-LEVEL AIR OF A CZECHOSLOVAK LOCALITY WITH RESPECT TO THE RADIOLOGICAL EXPOSURE OF ITS POPULATION. Vratislav Havlovic (Charles Univ., Hradec Kralove, Czechoslovakia). Health Phys., 11: 553-66(June 1965).

The concentration of natural radioactive aerosols carrying the decay products of radon and thoron was studied by taking samples daily at Plzeň, Czechoslovakia, during two sampling periods, 1957–1958 and 1959–1960, by the filtration method. The extrapolated radon concentration indicated a great dependence on the meteorological factors as was especially evident in the dry weather period of 8 weeks in 1959. The radon and thoron concentrations gave valuable information on the problem of the annual course of radon and thoron in the atmosphere. The absorbed dose-rate from the inhalation of the decay products of radon and thoron was estimated. At the average radon concentration in the ground-level air, 0.106 pC/l, the absorbed dose-rate in the lungs caused by the decay products of radon is 53 mRem/year. The average value of radon concentration at Plzeň and the estimated value of the absorbed dose-rate by inhalation are among the lowest of the usual values reported by others in various countries. Finally, the external whole-body gamma dose-rate from the decay products of radon was estimated. Results of 1.51 and 1.80 mRad in a year were obtained. (auth)

26591 THE OCCURRENCE AND RETENTION OF RADIONUCLIDES IN THE SEDIMENTS OF WHITE OAK LAKE. T. F. Lomenick and D. A. Gardiner (Oak Ridge National Lab., Tenn.). Health Phys., 11: 567-77(June 1965). (ORNL-P-331)

As a result of the discharges of large volumes of low-level radioactive liquid wastes to surface streams at the Oak Ridge National Laboratory, large quantities of radionuclides have accumulated in the bottom sediments of White Oak Lake. Ruthenium-106 (1038 C) and cesium-137 (704 C) account for more than 90% of the total activity now present at the site, while ^{60}Co(152 C), the rare earths (17 C, exclusive of ^{90}Y), and ^{90}Sr(15 C) make up the remainder. More than half of the activity is associated with the upper 6-in. sediment layer, while progressively smaller quantities of activity are found with depth. The ruthenium, which is restricted to a small area in the now dry upper lake bed, is partially water soluble; however, its rate of movement through the soil is slow enough so that radioactive decay reduces the concentration of that reaching surface streams to insignificant levels. Most of the ^{137}Cs occupies highly selective exchange sites on the illitic fraction of the clay in the sediment and can be desorbed only by disruption of the lattice structure. Only a small fraction of the ^{60}Co in the soil was found to be exchangeable. It is, therefore, unlikely that any large fraction of the ^{137}Cs or ^{60}Co would move from the area except through erosion of the sediment. About one-half of the ^{90}Sr and the rare earths in the sediment appears to be exchangeable, while the other half is in the form of slightly soluble salts. Through leaching by ground water, a slow depletion of strontium from the dry part of the lake bed occurs. The accumulation of radionuclides in the sediments of White Oak Lake illustrates the effectiveness of relatively quiescent bodies of water in concentrating activity in stream beds and in retarding the downstream movement of these materials. (auth)

26592 DEVELOPMENT OF EXAMINATIONS FOR THE EVALUATION OF RADIOLOGICAL HEALTH PERSONNEL. Lillian D. Long (American Public Health Association, New

York), Ruth S. Shaper, Dade W. Moeller, and Saul J. Harris. Health Phys., 11: 579-83(June 1965).

Under a contract with the Division of Radiological Health, U. S. Public Health Service, the Professional Examination Service of the American Public Health Association has over the past two years been engaged in a program for the development of a wide range of examinations for the evaluation of the professional knowledge, skills, and judgment of radiological health personnel. The immediate objectives of the program were to provide materials for the evaluation of the effectiveness of radiological health training programs and for the selection of people applying for radiological health positions in public health agencies. The project included the solicitation of approximately 2000 original questions from personnel actively engaged in the profession, the subsequent technical, editorial, and psychometric review of these items, and ultimately the compilation of selected questions from the pool, thus established, into examinations specifically designed for various categories of personnel. Examinations completed to date for state and local health department positions include those for radiological health specialists (two levels), radiochemists (two levels), and radiological health field representatives (or inspectors), covering the options of medical and industrial x ray, radioactive materials, and a combination of the two. The new examination materials are being used in the certification program of the American Sanitary Engineering Intersociety Board, in the evaluation of personnel by the Division of Commissioned Officers of the Public Health Service, and by the thirty-seven State and Local Health Departments that hold continuing contracts with the Professional Examination Service. (auth)

26593 THIMEROSAL—A PRESERVATIVE FOR MILK TO BE TESTED FOR RADIOACTIVITY. Anthony Lamanna, Victoria Yancik, T. P. Abbott, and John Holmes (Public Health Service, Washington, D. C.). Health Phys., 11: 586-7(June 1965).

Thimerosal was found to be an effective preservative for pasteurized milk to be kept at room temperatures of 20–30°C and to be analyzed radiochemically by methods utilizing ion exchange resins. The principal known advantage is that the preservative does not affect the removal of ^{131}I or ^{90}Y by an anion exchange resin. The minimum quantity of thimerosal required to preserve pasteurized milk held at a temperature of 23–24°C over a span of up to 2 weeks was found to be 5 mg/l of milk times the number of days that the milk is to be stored before analysis. (P.C.H.)

26594 RADIOISOTOPES IN THE 1964 DIET. Irving Michelson (Consumers Union of U.S., Inc., Mount Vernon, N. Y.). Health Phys., 11: 587-91(June 1965).

The levels of ^{90}Sr, ^{137}Cs, K, and Ca were determined in composite samples of teenage diets during the first half of 1964. The tests revealed distinctly higher levels of fallout in foods in 1964 than in 1963. In Feb. the levels of Sr units in 1964 were two to three times as high as they had been in 1963 in three of the cities, and the average of 9 cities included in both years' studies showed an increase of 75% over 1963. Also, the ^{137}Cs levels in two cities were 6 times as high as the 1963 levels; the average Feb. level in the 9 cities was three times as high in 1964 as in 1963. Data are tabulated. (P.C.H.)

26595 SURVEY OF X-RAY PROTECTION PRACTICES AMONG MICHIGAN VETERINARIANS. Gerald A. Jacobson and Donald E. Van Farowe. J. Am. Vet. Med. Assoc., 145: 793-7(Oct. 15, 1964).

According to a survey of veterinary radiologic equipment in use in Michigan, a high percentage of units did not have adequate aluminum filtration or cones that would confine the beam to the area of diagnostic interest. As a result, the scatter radiation dose to the operator was much higher than necessary for each radiograph taken. Twenty-five illegal hand-held fluoroscopes were found in use, and protective gloves and aprons were lacking in several animal hospitals. Few establishments used film badges or other devices to monitor radiation exposure. In addition to faulty equipment, a number of potentially dangerous procedures existed. Although veterinarians were aware of the dangers in using radiographic equipment carelessly and understood control techniques, many did not apply this knowledge to everyday practice. A visit was made to each veterinarian's office or hospital where a registered x-ray or fluoroscopic machine was located, and each unit was physically inspected and the radiation measured. Then the owner was sent a letter listing the necessary changes that would reduce overall radiation exposure. (P.C.H.)

26596 IODINE-131 IN WATER SUPPLIES AFTER NUCLEAR ATTACK. R. G. D. Osmond, J. R. W. Kerr, and P. Metson. J. Inst. Water Engrs., 18: 459-64(Oct. 1964).

An experimental study was undertaken in 1962 in an attempt to determine the degree of transfer of ^{131}I from a catchment area to stream waters, advantage being taken of the Autumn series of nuclear test explosions. The chemical form of the radioiodine puts it into a different category from most other fission products of immediate significance, since cation exchange alone would not reduce its concentration in water supplies. The study was, therefore, undertaken to obtain data that should be of interest in Civil Defense planning. Data are tabulated. (Public Health Eng. Abstr., 45: (Apr. 1965))

26597 DISTRIBUTION OF MAN-MADE RADIOACTIVITY IN THE NORTH PACIFIC THROUGH SUMMER 1955. Yasuo Miyake and Katsuko Saruhashi (Meteorological Research Inst., Tokyo). J. Marine Res. (Sears Found. Marine Res.), 17: 383-9(Nov. 28, 1958).

The radioactivity that originated from the Bikini and Eniwetok tests in the spring of 1954 was transported mainly to the west, then to the north toward the coast of Japan, and finally down south along the Kuroshio Current by summer 1955. Activity in contaminated areas where activity in sea water was greater than 0.1 $\mu\mu$C of ^{90}Sr/l averaged 4.2×10^6, 1.9×10^7, and 2.7×10^7 km^2, respectively in June 1954, March–April 1955, and August–September 1955. In spring 1955 the activity extended down to about 600 m below the surface. Vertical distribution of radionuclides might be influenced less by vertical migration and decomposition of marine life than by physical mixing. A horizontal eddy diffusion coefficient of $0.8–1.4 \times 10^9$ was obtained from the time change of distribution of radioactivity in the ocean. (auth)

26598 AN ESTIMATION OF RADIATION INJURY IN X-RAY TECHNICIANS IN JAPAN. Takashi Kitabatake (Nagoya Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 999-1006(Nov. 1964). (In Japanese)

Frequency of the late radiation injuries that would possibly occur in x-ray technicians at present or in the future is estimated. Among x-ray technicians in Japan about 5 cases of leukemia were expected in 1964, nearly 25 times the incidence in the general population, although an actual survey did not show any increase. Discrepancy between the expected and actual may be produced by an inaccurate survey. About 2.8 times the incidence of skin cancer and 1.8 times the incidence of deep-seated cancer were expected in x-ray technicians in 1964, as compared with the general population. However, the incidence of skin cancer in x-ray workers in Aichi Pref. was about 20 times that of the general population actually. The radiation dose received by the hand in old x-ray technicians might have been more than the dose received by the whole body. The sex ratio in offspring of x-ray technicians at present was estimated to be the sex ratio in the general population plus 0.023571. This is the same level as the actual survey. From the above three estimations, the estimated radiation dose received by the x-ray technicians seems to be reasonable. (auth)

26599 RADIOACTIVE CONTAMINATION OF COTTON FIBER BY URANIUM AND ITS REMOVAL. Yoshiki Wadachi and Yuzo Tajima (Japan Atomic Energy Research Inst., Tokyo). Nippon Kagaku Zasshi, 86: 381-4(Arp. 1965). (In Japanese)

Various factors affecting the radioactive contamination of cotton fiber by uranium nitrate were investigated quantitatively by neutron activation analysis. The experimental results were explained successfully by specific interaction of the fiber and the contaminant, taking

account of the dissolved states of the uranyl ion. Experiments were carried out with a standard test machine, in an effort to find out the best condition for removing the contaminant from the soiled fiber. An aqueous solution (0.1 mol/l) of sodium bicarbonate or ammonium oxalate proved to be the best decontaminant. It is also shown that the contaminating species is removed solely as uranyl ion when the pH of the decontaminant solution is lower than 3. (auth)

26600 RADIATION EXPOSURES IN FABRICATING $^{233}U-Th$ FUELS. J. P. Nichols, R. E. Brooksbank, and D. E. Ferguson (Oak Ridge National Lab., Tenn.). Nucl. Appl., 1: 176-8(Apr. 1965). (ORNL-P-703)

Radiation levels and exposures associated with the operation of the ORNL Kilorod Facility for the fabrication of $^{233}UO_2-ThO_2$ fuel were determined and are analyzed. Comparison between the measured activity of ^{208}Tl during a typical sequence of operations and the calculated activity of pure ^{232}U demonstrated the effects of the several fabrication steps. Conceptual design calculations for a semi-continuously operating plant indicated that up to 100 kg/d of mixed oxide containing 200 parts/10^6 ^{232}U can be processed using 2-in.-thick (5.1 cm) lead-equivalent shielding. (auth)

26601 STUDIES ON RADIOACTIVE FALL-OUT IN THE CALCUTTA AREA. (Bose Inst., Calcutta). Sci. Cult. (Calcutta), 28: 371-5(Aug. 1962).

Plants and rain water were monitored for radioactivity from fallout in Calcutta. Appreciable radioactivity was found in the dust samples collected on plant leaves over Calcutta and surroundings. The results showed that the radioactive materials brought down by rain water varied arbitrarily in amount as well as in the distribution of activity between soluble and insoluble portions. Meteorological conditions associated with the unusual radioactive fallouts on April 23 and June 18, 1962, over Calcutta are discussed. (P.C.H.)

26602 "TRINITITE": COBALT-60, CESIUM-137, AND EUROPIUM-152. Leonard P. Salter and John H. Harley (Atomic Energy Commission, New York). Science, 148: 954-5(May 14, 1965).

Cobalt-60, cesium-137, and europium-152 were identified in trinitite, an artificial mineral produced in the first nuclear explosion at Alamagordo, New Mexico, in 1945. Cesium-137 is an expected fission product, but the origin of the other two radionuclides is not certain. (auth)

26603 ASSESSMENT OF RADIOACTIVITY IN MAN. VOL. II. Proceedings of the Symposium Held at Heidelberg, 11-16 May 1964. (International Atomic Energy Agency, Vienna). Proceedings Series. Nov. 1964. 666p. (STI/PUB/84(Vol.II); Conf-448(Vol.II)). $13.00; S 273.-; £ 3.18.0; F.Fr. 52.-; DM 45.50(IAEA).

Forty-seven articles are included; separate abstracts were prepared for 24. The remaining 23 articles were previously abstracted in NSA as 18: 23825, 25687, 25710, 33260, 33261, 33262, 33263, 33265, 33267, 33268, 33269, 33424, 33425, 33426, 33427, 33429, 33820, 35300, 35406, 36943, 36944, and 19: 7209 and 15343. (P.C.H.)

For abstracts of individual papers see: 25893, 25894, 25895, 25896, 25897, 25898, 25899, 25900, 25901, 25902, 26604, 26605, 26606, 26607, 26608, 26609, 26610, 26611, 26612, 26613, 26614, 26615, 26616, and 26617.

26604 NOTE ON TWO TYPES OF CONTAMINATION OF HUMAN BEINGS BY CESIUM-137. L. Jeanmaire (Centre d'Etude Nucleaires, Fontenay-aux-Roses, France). p.75-8 of STI/PUB/84(Vol.II). (In French)

An elimination curve for a case of occupational contamination by cesium-137 is presented. Variation of the cesium-137 body burden during 1963 in a group of persons who did not undergo occupational exposure is also included. (P.C.H.)

26605 CESIUM-137 IN GROUPS OF POPULATIONS. J. K. Miettinen (Univ. of Helsinki). p.115-20 of STI/PUB/84(Vol.II).

The ^{137}Cs body burdens in various regions are reviewed and data are compared. Factors affecting the body burdens include: amount of fallout; type of diet; and the average biological half time of ^{137}Cs in the population group in question. Body burdens in Japan were found to be much lower than in the other regions. The curves of the U. S., Italy, Germany, and France run fairly parallel with each other but are below the curves of southern Finns and Englishmen from West Cumberland. Recommendations for calculating ^{137}Cs body burdens are given. (P.C.H.)

26606 MEASUREMENT OF CESIUM-137 IN THE NORMAL PERSON. E. J. Huycke and E. Oberhausen (U. S. Army Medical Research Unit, Landstuhl/Pfalz, Ger.). p.135-41 of STI/PUB/84(Vol.II).

During the period June 1959 to October 1963 the Landstuhl whole-body counter measured the cesium-137 content of more than 15,000 normal persons. The monthly averages of these measurements indicate a steady increase in the cesium-137 content since June 1962. This increase has become more rapid during the period June 1963 to October 1963. A further evaluation of the monthly averages since June 1962 indicates a mean biologic half life of cesium-137 of 140 d for persons older than 22 yr. A comparison of the mean cesium-137 content of persons between 8 and 17 yr of age with those older than 22 appears to indicate that the biologic half life of cesium-137 is shorter in the younger people. This is in agreement with earlier data from this counter concerning measurements of cesium-137 content between June 1959 and December 1960; these data showed a lower cesium-137 content in children than in adults. Another evaluation of recent data from this unit concerns the standard deviation (sigma) of the cesium-137 content in a large population. From this population the sigma of measured cesium/g body potassium values is 33%. This is more than twice the sigma of the body potassium content of the same population. By comparing a group of persons who have undergone several repeat assays over an extended period of time with the monthly means of the total population measured, it was found that the large sigma of cesium-137 content cannot be caused solely by the varying diets of the population measured. (auth)

26607 IN VIVO MEASUREMENTS OF Cs^{137} WITH A HUMAN BODY COUNTER. C. Melandri (Comitato Nazionale per l'Energia Nucleare, Bologna) and O. Rimondi. p.143-54 of STI/PUB/84(Vol.II).

Data are given on the first measurements of human body radioactivity made in Italy with a whole-body counter. The counter shielding is made of iron bricks 16 cm thick. Measurements inside are 270 cm × 200 cm × 200 cm. The detectors are a 9 in. × 4 in. NaI(Tl) crystal and three 30 cm × 20 cm × 17 cm plastic scintillators, which can be used separately, in parallel, or in anticoincidence and in coincidence with the crystal. The counter was used for determining the behavior of the cesium-137 body content from fallout in the whole population and for estimating the cesium-137 retention in a subject accidentally contaminated. The first measurements of cesium-137 body content from fallout were taken on 13 subjects in December 1962 and continued regularly at three-month intervals. A gradual increase was noted in the average cesium-137 content of the population throughout the whole of 1963 up to the value of 124 pC/g of potassium in September. In a case of accidental contamination from cesium-137 (about two years before the counter was built) measurements were made in order to determine both the effective half life of the long-term component and the initial intake of the radioelement. (auth)

26608 THE ENHANCED RADIOCESIUM LEVELS OF PEOPLE IN NORTHERN SWEDEN. K. Liden and Y. Naversten (Univ. of Lund, Sweden). p.167-82 of STI/PUB/84(Vol.II).

After the discovery of the high cesium-137 body activity of Swedish Lapps early in 1961 measurements were performed on large groups of Lapps and other Swedes on a similar diet. In September 1961, 162 persons from an area close to the arctic circle were measured in a semi-portable whole-body counter. In the Lapp group cesium-137 levels ranging from 15 to 690 nC were found. At the same place a group of 157 persons were counted in April 1962. At that

time the cesium-137 range was 30 to 740 nC. During a five weeks' expedition to seven different centers in northern Sweden in April 1963, a total number of 458 persons were studied by means of the same counter set up in a bus. The cesium-137 range for Lapps in the above mentioned area was then 50 to 900 nC. The average cesium-137 body activity of all the adult male reindeer breeders (78 persons) measured in April 1963 was 461 nC. The maximum body activity found was 1340 nC cesium-137. Details are presented on the variation of cesium-137 in human beings with age, sex, occupation, and diet as well as on the seasonal and geographical variation found. An increase in the average cesium-137 body activity was observed from 1961 to 1963. For comparison, non-Lapps were also counted. Almost all of them also showed a substantially enhanced cesium-137 level if compared with persons in southern Sweden. The radiation dose from cesium-137 is in many cases two to three times as large as the potassium-40 dose, the observed maximum giving a dose eight times that of the potassium dose. (auth)

26609 CALCULATION OF TOTAL BURDEN TO BONE TISSUE THROUGH INCORPORATION OF RADIUM-226. V. M. Malykhin and V. P. Shamov (Inst. of Radiation Protection, Leningrad). p.253-65 of STI/PUB/84(Vol.II). (In Russian)

A calculation method for determining body burden due to radium-226 is described. The activity of the excreta and the time of contact with radium constitute the starting data. The results can thus be used by a wide circle of radiobiologists not possessing special apparatus for determining radium burden by exhaled radon or by measurement of the γ activity of its daughter products with the aid of large counters. Values of the effective excretion constant λ_{eff} for contact times t_1 = 2, 4, 6, 8, and 10 yr and elapsed times after contact t_2-t_1 = 2, 4, 6, 8, and 10 yr are given. These values are obtained on the basis of an exponential excretion model and uniform uptake of radium by the body over the period of contact. Using the values of λ_{eff} it is possible to determine the radium content of the skeleton from the excreta activity. On the basis of these same model assumptions, an analytical expression is obtained for the dose to the skeleton for the whole time since start of contact. For the sake of convenience the results are presented as a graph of the dose coefficient K_D, which is equal to a dose of 1 pC Ra/day in the excreta. The magnitude of the dose is determined by simply multiplying the activity of the excreta by the calculated dose coefficient K_D. (auth)

26610 TWO CASES OF CHRONIC OCCUPATIONAL EXPOSURE TO RADIOACTIVE MATERIALS. J. Rundo (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.291-306 of STI/PUB/84(Vol.II).

The results and interpretation of measurements of radioactivity in the bodies and in the excreta of two subjects with a long (up to 16 yr) history of exposure to radium-226, strontium-90, and thorium-228 are described. Measurements were made in 1957, 1959, 1960, and 1963. The radium content of subject A showed no perceptible decrease between 1957 (0.13 μC) and 1963 (0.14 μC), and it was more than 30% higher in 1959. The excretion rate observed in 1957 was consistent, on the power function retention model, with a chronic intake of about 2 nC/d for the previous 10 yr, while the much lower excretion rate in 1963 indicated that there had not been a recent intake. The radium content of subject B decreased from 1.19 μC in 1959 to 1.07 μC in 1963, at a rate corresponding to a biological half life of about 25 yr, yet the excretion rate in 1963 suggested a much faster fall in body content. This suggested that there had been a small intake of radium not long before. The strontium-90 content of subject A decreased from 5.0 μC in 1957 to 3.0 μC in 1963, corresponding to a biological half life of about 9 yr. Consideration of a power function retention model for strontium in man showed that the findings were consistent with a chronic intake for four years up to 1957 and then no further large intake, although as the excretion rate observed in 1963 was at least five times greater than that calculated there may have been a small intake shortly before the measurements in 1963. The retention of strontium-90 by subject B indicated a biological half life of about 6 yr, agreeing with that deduced from the excretion rate (4.5–8.0 yr). After an initial four-fold increase, the thorium-228 content of subject A decreased exponentially between 1959 and 1963 with an effective half life of at least 1.4 yr. Subject B's content increased from 1959 to 1960, but the decrease from 1960 to 1963 was not significantly different from that due to radioactive decay with a half life of 1.90 yr. The value of the exponent in the power function retention equation for radium in man is discussed. (auth)

26611 THE EFFECTS OF INTERNAL CONTAMINATION WITH RADIONUCLIDES CONTAINED IN LUMINOUS PAINT. M. Kilibarda, M. Medjedovic, M. Jeremic, D. Djuric, and S. Gvozdanovic (Inst. of Occupational Medicine, Belgrade). p.307-15 of STI/PUB/84(Vol.II).

Thirty-six workers were exposed to internal radiation from radionuclides during a number of years. The health condition of these workers was checked continuously and systematically during the last year. In the health control were included clinical and hematological examinations and radiography of the bones. Special attention was paid to the determination of radionuclides in urine (quantitative determination of polonium, radium, and thorium) and in the body (whole-body counting). The clinical results, hematological changes (anemia, leukopenia, leukocytosis, lymphopenia, and thrombocytopenia), whole-body counting measurements, and the values of polonium (from 0–30 pC/l) and radium (from 0–24.0 pC/l) in the urine are presented and discussed. The results of the health control of workers previously exposed to internal contamination at some places of work are also given. Hygienic conditions in the luminous paint industry where the controlled people were engaged are presented. (auth)

26612 ASSESSMENT OF THE BODY BURDEN OF STRONTIUM-90 AND RADIUM IN MAN. P. Wenger and K. Soucas (Service Cantonal de Controle des Irradiations, Geneva). p.363-83 of STI/PUB/84(Vol.II). (In French)

The Geneva whole-body counter was calibrated for strontium-90, using the bremsstrahlung of the standards supplied by the International Atomic Energy Agency, i.e. source No. 3 (strontium-90 content–10.55 μC on 26 February 1963), placed in the center of a plaster of paris shell. The conditions in which whole-body counting can be used to measure strontium-90, in the presence of radium, and the energy regions for measuring these two elements simultaneously were determined. The radium standards consisted of sources containing 0.1, 0.2, 0.5, and 1 μC of radium-226. In calibrating the whole-body counter, either contaminated individuals or a phantom with the average absorption characteristics of these individuals were used. The 175-cm arc technique was used for the purpose of calibration. On the basis of the values obtained by the arc, the tilting chair was calibrated in order to carry out measurements more quickly. The methods of analyzing data and interpreting measurements are described. The cases measured with the whole-body counter were followed up for several months with a view to determining the amount of strontium-90 in urine excretion. These measurements enabled the patterns of strontium-90 excretion to be determined as a function of the time that elapsed since chronic contamination ceased. Blood measurements also made it possible to compare the total retention of strontium-90 by the body, as determined by the whole-body counter, with the level of activity in the blood and the rate at which it was excreted in the urine. With a view to improving the interpretation of results, the chemical forms and the solubility of the contaminant, together with the mode of contamination are specified. (P.C.H.)

26613 HUMAN INTERNAL CONTAMINATION WITH STRONTIUM-90 TITANATE. F. J. Bradley, N. Wald, and R. L. Wechsler (Univ. of Pittsburgh). p.401-16 of STI/PUB/84(Vol.II).

Strontium-90 was used in multikilocurie quantities recently as a heat source for the thermoelectric generators. The titanate was carefully selected for this purpose as the

chemical form that best met requirements including inertness to corrosive attack in the event of accidental release to the environment. An industrial accidental exposure of one worker on 26 June 1963, to strontium-90 titanate powder, originally in the form of particles of about 120 μm and less, provided an opportunity to attempt the assessment of the human body burden of this supposedly highly insoluble compound. Because of the physical and biological behavior of the particles, it was assumed that the actual particle size that was dispersed and ingested and/or inhaled by the exposed person was in the range of 1 to 30 μm. Three techniques were used to estimate the body burden. Whole-body radiation counting, which only gave an upper limit because of the non-specific bremsstrahlung spectrum from strontium-90–yttrium-90, indicated an initial total-body burden of 4.8 μC. The second method, total urinary and fecal output collection, totaled 5.0 μC for the first 20 d. Combining that amount with an estimate of the amount retained in the body, an initial total-body burden of 5.2 μC was obtained. The third technique, blood radioactivity determination, indicated an initial total-body burden of 6 μC. The ratio of fecal to urinary output in the first 20 d was 15 to 1, and 94% of the total strontium-90 excretion was via the gastrointestinal tract. It is of interest, however, that a significant fraction was evidently soluble. By the 20th post-incident day, it was estimated that the retained body burden was only 5% of the total intake. Methods used in that period to enhance fecal excretion by $MgSO_4$ and urinary excretion by a combination of Ca-gluconate and NH_4Cl are described. Subsequent excretion patterns and the current estimate of the retained body burden are presented. (auth)

26614 DETECTION AND EVALUATION OF URANIUM EXPOSURES. L. M. Scott and C. M. West (Union Carbide Corp., Oak Ridge, Tenn.). p.523-33 of STI/PUB/84(Vol.II). (Y-KB-34)

Approximately 1800 personnel of the Union Carbide Corporation-operated United States Atomic Energy Commission Y-12 Plant are involved in the routine industrial-scale processing of uranium. Personnel monitoring is accomplished by means of urinalysis and in vivo gamma-spectrum analysis programs. The interpretation of data from the two programs and the relationship thereof are presented. Personnel-monitoring results from the two programs are divided into four classes: low urinalysis and low in vivo results; high urinalysis and low in vivo results; low urinalysis and high in vivo results; and high urinalysis and high in vivo results. The majority of the persons monitored fall into the first class; however, from the exposure standpoint the last three classes are of prime interest. Examples of cases falling into these classes are presented. Cases exhibiting biological half life in the lung, ranging from less than 100 days to approximately 800 days, are presented and discussed. Correlation coefficients for results of the two programs, grouping data by type work, are also presented. Correlations ranged from 0 to +0.32. (auth)

26615 A CASE OF INHALATION OF ENRICHED URANIUM DUST. W. N. Saxby, N. A. Taylor, J. Garland, J. Rundo, and D. Newton (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). p.535-47 of STI/PUB/84(Vol.II).

Results obtained in the study of a case of inhalation of insoluble enriched uranium dust are presented. The operational background to the case is explained. The results of urine and fecal sampling, and of body radioactivity measurements are presented and discussed. Tentative conclusions include an assessment that the apparent half life of insoluble uranium dust in the chest was about 1 yr and a note on the fact that the excretion data do not apparently account for all the material leaving the chest, the fact that the fecal excretion rate was higher than the urinary excretion rate for about 1½ yr after inhalation, and the suggestion that at times between 30 and 60 days a factor of 500 may be used to convert daily urinary uranium excretion levels to the level retained in the lung. (auth)

26616 THE INTERPRETATION OF DATA RELATING TO PLUTONIUM CONTAMINATION. L. Jeanmaire, F. Patti, and M. L. Audren (Centre d'Etude Nucleaires, Fontenay-aux-Roses, France). p.617-28 of STI/PUB/84 (Vol.II). (In French)

Data for plutonium levels measured in various samples after heavy contamination through the skin are presented, and the progress of elimination during the year following contamination are reported. Data resulting from measurements after very slight contamination, and attempts to interpret them are also presented. (auth)

26617 RESEARCH WITH A VIEW TO ESTIMATING THE BODY BURDEN OF RARE EARTHS ON THE BASIS OF EXCRETA MEASUREMENTS. J. Lafuma, J. Remy, J. C. Nenot, F. Marchetti, and W. Skupinski (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). p.629-36 of STI/PUB/84(Vol.II). (In French)

It is shown that various factors, such as the nature of the anionic radical, the valency of the element, the physico-chemical state of the contamination form, and the channel and manner of contamination, mainly affect the initial kinetics of distribution in the body during the very first minutes. Using high-speed recording techniques and varying several experimental parameters, studies were made on the effect of these parameters on initial kinetics, the subsequent evolution of contamination in the various tissues, and elimination processes. In particular, the kinetics of bile and urine elimination, blood purification, and the radioactivity level of various organs (liver, kidneys, lungs) were recorded. In order to relate the body burden to the quantities of radioisotope eliminated, it is necessary to know the amounts present in the various compartments, their rates of exchange, and the times required for elimination by the various channels. In an attempt to clarify these points, a test using a chelating agent that modifies the equilibria between compartments and directs all available cerium towards the elimination channels was devised. By comparing the elimination values measured before and during the test, attempts were made to calculate the total body burden and its distribution. Ways of applying this test at various stages in contamination are discussed. (P.C.H.)

26618 SPRAVOCHNIK PO ZASHCHITE OT IZLUCHENIYA PROTYAZHENNYKH ISTOCHNIKOV. (Handbook on Protection Against Radiation from Extended Sources). B. R. Bergel'son and G. A. Zorikoév. Moscow, Atomizdat, 1965. 176p.

The handbook contains data necessary for calculating radiation doses from various extended sources. The geometry of emission sources and shielding, equations describing the flux and current of non-scattered radiation behind the shielding, integrated equations, and physical data for analyzing the emission sources and shielding are given. (R.V.J.)

26619 RADIOACTIVE FALLOUT, SOILS, PLANTS, FOODS, MAN. Eric B. Fowler, ed. Amsterdam, London, and New York, Elsevier Publishing Company, 1965. 321p.

Information is included on: biospheric contamination by radioactive fallout; availability of exchangeable and non-exchangeable ^{90}Sr to plants; relation between soil, plant, and radioisotope; fission product uptake by plants; above ground plant parts as pathway for entry of fission products into food chain, especially $^{89-90}Sr$ and ^{131}Sr; natural radioisotopes in foods and food source materials; radioisotopes in milk, transport mechanisms influencing ^{90}Sr levels in milk; transfer of fallout from diet to man; radioisotopes in man from nuclear tests; and methods of assessing fallout. (P.C.H.)

26620 THE DEVELOPMENT OF AN INDIVIDUAL DOSIMETER FOR MEASUREMENT OF HIGH-LEVEL RADIATION DOSES. H.-J. Hardt (Bundesamt fur Zivilen Bevolkerungsschutz, Bad Godesberg, Ger.). Vienna, International Atomic Energy Agency, World Health Organization, 1965, Preprint No. SM-56/20, 9p. (CONF-650302-13).

From IAEA Symposium on Personnel Dosimetry for

Accidental High-Level Exposure to External and Internal Radiation, Vienna.

A dosimeter was developed during the last few years, which seems to be suited for general use in the measurement of high doses in radiation protection. It consists of a phosphate glass with energy filter; the case is water- and dust-proof and the connection with an identity disc is possible. The properties of the phosphate glass as well as the results of tests on temperature and time response, the dependence from energy and direction of radiation, and the influence of the dose rate are discussed. (auth)

26621 THE ROLE OF DOSIMETRIC STUDIES IN THE MANAGEMENT OF OVER-EXPOSURES. K. P. Duncan and H. J. Dunster (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, World Health Organization, 1965, Preprint No. SM-56/15, 12p. (CONF-650302-11)

From IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna.

The term over-exposure has come to mean any exposure in excess of ICRP recommendations or their national equivalents. The biological implications of such events are usually trivial but may be serious or even fatal. The administrative and legal implications depend on the extent to which the recommendations have been incorporated into rules and regulations. A clear distinction is called for between the biological and administrative implications, and this is especially important in the management of over-exposures. Legal or administrative sanctions following over-exposures can be based on a numerical estimate of the dose in relation to the maximum permissible value. In contrast, sanctions aimed at safeguarding the health of the individual must be related to the likely biological effect of the dose already received and of expected future doses. Dosimetric studies may have administrative, legal, and biological implications, and examples of the way in which such studies can be used for all these purposes are given. (auth)

26622 A CRITICALITY DOSE ASSESSMENT SYSTEM. J. W. Smith, S. J. Boot, and J. A. Dennis (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, World Health Organization, 1965, Preprint No. SM-56/16, 13p. (CONF-650302-12)

From IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna.

A description is given of the system of dosimetry devised at Harwell and adopted throughout the U.K.A.E.A. Details are given of the operational procedures, personnel dosimetry, and dose assessment. The results of practical exercises at Harwell are discussed. Personnel dosimetry is based on lockets containing sulfur, gold foils, and indium, together with phantoms installed in hazard areas. This system has been verified experimentally where possible. Phantoms wearing dosimeters were irradiated by critical assemblies of measured and calculated spectra, and the readings correlated to the known dose. Experiments are described and results of general interest, e.g. attenuation produced by the body, are given. Body sodium activation is of great importance in criticality accident dosimetry, and was investigated in great detail. Besides using phantoms with critical assemblies, the capture probability was determined with monoenergetic neutrons. In vivo experiments gave the relationship between man and phantom and also the sodium/chlorine ratio in blood samples, urine samples, and whole-body monitoring. These results are given. Interpretation of the data after an accident will be based initially on a neutron spectrum convention, which is discussed, together with the different possible dose specifications. The magnitude of probable errors, initially and finally, are given. (auth)

26623 PERSONNEL DOSIMETRY OF ACCIDENTAL HIGH-LEVEL EXTERNAL EXPOSURES WITH THE AID OF OPTICAL AND THERMOLUMINESCENCE GLASSES. Zd. Spurny (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Vienna, International Atomic Energy Agency, World Health Organization, 1965, Preprint No. SM-56/25, 10p. (CONF-650302-9)

From IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna.

Some special glasses suitable for accidental dosimetry were developed and their physical properties measured. Phosphate glass, activated with manganese, composition [$MgO.P_2O_5-Al_2O_3.3P_2O_5$] Mn, is very suitable as a solid-state detector of ionizing radiation. It was developed as a dosimeter for the range of 0.1 to 10^4 Rad; it has no fading and its energy dependence is reduced by a metal sheath so that energy response is nearly constant. Coloration of these glasses appears at relatively higher doses than thermoluminescence. Borate glasses (composition $Na_2O.2B_2O_3$) show thermoluminescence in the range of 1 to 10^3 Rad and their coloration link-up with the range of 10^3 to 5.10^5 Rad. Both phenomena have fading. Some other special glasses were studied as coloration and thermoluminescence detectors and their parameters are given. The relation between coloration and thermoluminescence induced by different kinds of radiation is described. By the method of thermal destruction the energy necessary for decoloration and for the destruction of luminescence traps were measured. The depth of traps as the only criteria for dosimetry evaluation of glasses is discussed. The practical accidental dosimeters used in Czechoslovakia (crystals and glasses) are briefly reviewed. (auth)

26624 PHOTOGRAPHIC DETECTION OF HIGH LEVEL EXPOSURE. J. Kubal, J. Benes, and J. Trousil (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Vienna, International Atomic Energy Agency, World Health Organization, 1965, Preprint No. SM-56/24, 10p. (CONF-650302-19)

From IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna.

For the determination of accidental doses of ionizing radiations two methods based on a convenient chemical treatment of irradiated film dosimeters were proposed and experimentally investigated. The first is based on the destruction of latent image before standard development and uses the oxidative influence on the latent image by means of chromic acid. In this way the developing ability of silver halogenides decreases, so that after development measurable optical densities result even for high-level exposures (150 R). The destruction degree as well as the maximum attainable density depend on the concentration of the oxidative solution used. The principle of the second method assumes restraining action of chemical development by an admixture of the so-called stabilizers or antifoggant agents to the developing solution. These substances show a desensibilizing effect on photographic layer and their inhibition of developing process allows to attain standard optical densities with over-exposed materials. The best results are obtained with benzotriazol and phenylmercaptotetrazol. This method is advantageous by the decrease of the basic fog of sensitive layer even at a multiple lengthening of the developing time. Both methods, though very different, reach the same results. With highly sensitive x-ray films, used in standard dosimetry, doses up to 150 R could be measured. The experiments with less sensible materials have shown that the applicability range of the film method may in this way be further extended. (auth)

26625 PORTABLE GAMMA RADIATION MONITORS, WITH ENERGY-SELECTIVE FACILITIES, FOR RAPID ASSESSMENT OF ACCIDENTAL HIGH LEVEL EXPOSURES. R. J. May and S. H. W. Tarrant (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Vienna, International Atomic Energy Agency, World Health Organization, 1965, Preprint No. SM-56/14, 50p. (CONF-650302-10).

From IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna.

Two portable gamma radiation monitors designed to have an energy-selective mode of operation are described. The portable gamma spectrometer (NIS 292) can be used to obtain the spectral distribution of any gamma radiation field within the energy range 6 kev to 7.5 Mev. It may also be used to record continuously a selected part of the spectral distribution. A simple, portable energy-selective gamma monitor (NIS 322) incorporates facilities for monitoring predetermined portions of the spectral distribution and can be used by unskilled personnel. Trials and laboratory tests have established that energy selection can be used to advantage in various applications relevant to accidental high-level exposure situations, such as, assessment of dose to personnel exposed to fast neutrons by measurement of ^{24}Na in blood-stream; the measurement of ^{131}I contamination of milk; and the uptake of ^{131}I in the thyroid gland. (auth)

INSTRUMENTATION

General

Refer also to abstracts 26219, 26728, 26915, 26917, 26925, 26973, and 27735.

26626 (AD-611007) A PHOTO-CURRENT SUPPRESSOR GAUGE FOR THE MEASUREMENT OF VERY LOW PRESSURES. W. C. Schuemann (Illinois Univ., Urbana. Coordinated Science Lab.). Oct. 1962. Contract DA-36-039-SC-85122. 14p. (R-156) $1.00(CFSTI).

An ionization gage was designed which removes the low-pressure limitation due to x rays found in conventional ionization gages while maintaining a comparable sensitivity. In this gage, an additional electrode establishes an electric field which repels photoelectrons ejected from the ion collector. A similar photocurrent from the suppressor grid is prevented by shielding this electrode from the x rays. Preliminary experimental results verified the suppression of photo-currents; pressures as low as 2×10^{-12} torr were measured. (auth)

26627 (CALT-221-7) RELATIVE INTENSITIES OF X-RAY REFLECTIONS OF VARIOUS ORDERS FOR TEN CRYSTAL MONOCHROMATORS. Technical Report No. 32. Pol Duwez (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Jan. 1965. Contract AT(04-3)-221. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The relative intensities of the higher order x-ray reflections of ten commonly used monochromator crystals were measured. Results show all the stronger reflections of the various crystals concentrated at the lower end of the 2θ scale. Several relatively strong reflections occur at higher Bragg angles and may be acceptable for the design of instruments involving monochromators or analyzing crystals. (W.L.G.)

26628 (CEA-R-2581) CALORIMETRE ADIABATIQUE A VIDE STATIQUE POUR LA MESURE D'ECHAUFFEMENTS DE MATERIAUX EN PILE. (Adiabatic Calorimeter With Static Vacuum for the Measurement of the Heating of In-Pile Materials). Jim Brun (Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucléaires). Dec. 1964. 79p. Dep.(mn).

Various interaction processes occurring between radiations present in nuclear reactors and matter are reviewed. Calorimetric methods that may be used for measuring the energy absorbed in the materials are described. The adiabatic calorimeter, the associated measurement device, and the calibration methods chosen are described. Values are given for the heating produced at various experimental positions in the EL 2 and EL 3 reactors for several materials used in reactor construction. (auth)

26629 (ECOM-2519) A TAPE RECORDER NEGATIVE-TIME AND TRANSIENT TRIGGERING SYSTEM. R. I. Rubinstein and Martin L. Long, Jr. (Army Electronics Labs., Fort Monmouth, N. J.). Oct. 1964. 17p.

A Negative-Time and Transient Triggering System (NETATT) has improved the systematic playback of transient phenomena stored on magnetic recording tape. A specific recorded trigger signal previously required to initiate the oscilloscope display of the recorded transient phenomena is no longer necessary. The NETATT System described herein utilizes the passage of the transient phenomenon or any other simultaneously recorded transient signal across the recording head of the tape recorder as the trigger. Since the recording head in most tape recorders precedes the playback head, the system significantly increases the amount of pre-transient display available and permits the experimenter to locate the displayed transient on any preselected portion of the oscilloscope screen at varying sweep speeds without the loss of desirable information. The NETATT System provides many of the advantages of a tape searcher without incorporating its disadvantages. The NETATT System, which has a negligible cost and complexity, is capable of performing functions that are impossible to perform with a tape searcher. The specific transient radiation effects observed on a photomultiplier tube with the NETATT System are described. (auth)

26630 (GEMP-300) STATIC SWITCHING PROGRAM. Final Report. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Apr. 21, 1965. Contract AT(40-1)-2847. 27p. Dep.; $2.00(cy), 1(mn) CFSTI.

An approach to a reactor scram bus is described which utilizes all solid-state components except for the transition from electrical energy to mechanical energy to drive actuators. Controlled rectifiers are used in place of relays. Transistors are used in place of vacuum tubes. Unitunnel diodes are used as the signal level detecting devices. (auth)

26631 (IAE-696) MNOGOKANAL'NAYA REGISTRIRUYUSHCHAYA SISTEMA NA GIBKIKH MAGNITNYKH DISKAKH S PLAVAYUSHCHIMI GOLOVKAMI. (Multichannel Recording System Utilizing Flexible Magnetic Disks With Floating Heads). A. P. Tsitovich (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1964. 14p. Dep.(mn).

The advantages of a cyclic memory system with magnetic data register are discussed. Descriptions are given of the design and performance of a new completely transistorized system with flexible magnetic discs and floating heads. The logic scheme for digital system memory is given. Fast-action cyclic systems with a buffer intermediate memory and dynamic register for multiple measurements are analyzed. (R.V.J.)

26632 (INP-317) DWUKANALOWY SPEKTROMETR FOTOELEKTRYCZNY. (A Double-Beam Photoelectrical Spectrometer). H. Niewodniczanski, K. Melzacki, J. Pietruszka, and J. Pilawa (Institute of Nuclear Physics, Krakow (Poland)). Oct. 1964. 21p. CFSTI.

The design and construction of a new optical spectrometer is described. Two exit slits isolate the selected lines in the spectrum of a standard spectrograph. The emerging radiation is brought to the cathode of the photomultiplier tube by means of two plane mirrors and special guide pipes with reflecting inside walls. Each exit slit can be moved along the spectrum by means of the long micrometer screw. The instrument described records either a time-resolved spectrum of a pulsed event or the total spectrum of a constant intensity radiation source. (auth)

26633 (INR-593/IA/PH) SOME APPLICATION OF AVALANCHE TRANSISTORS IN HIGH-SPEED DISCRIMINATORS. J. Kalisz (Institute of Nuclear Research, Warsaw (Poland)). Jan. 1965. 13p. Dep.

A fast discriminator including avalanche trigger circuit with resistance load (delay line) is described. Applications to the discrimination of the pulses from the scintillation counters and semiconductor particle detectors are presented. (auth)

26634 (LA-DC-6856) OPTIMIZING ZOOM SYSTEMS WITH THE LASL LENS DESIGN PROGRAM. Charles A. Lehman (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 17p. (CONF-650424-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Optimization Techniques Symposium, Pittsburgh.

A discussion is presented of the techniques used in the design of optical systems requiring simultaneous optimization under several conditions of use. Zoom (varifocal) lenses are included in the category of systems susceptible to these techniques. Performance data on a real zoom system designed with the aid of this program are included. (auth)

26635 (NASA-CR-228) INSTRUMENTATION FOR MEASUREMENT OF COSMIC NOISE AT 0.75, 1.225 AND 2.0 Mc/s FROM A ROCKET. H. F. Schulte, H. W. Estry,

R. L. Miller, and J. W. Kuiper (Michigan Univ., Ann Arbor). May 1965. Contract NASw-54. 117p. $4.00(CFSTI).

Design considerations and performance characteristics are given for a complete rocket-borne instrumentation system for absolute intensity measurements of r-f noise energy. The system includes a radioastronomy antenna, radiometers, and a dummy antenna for in-flight noise calibration. Also described are the telemetering systems, power supplies, accelerometer, and tests. (D.L.C.)

26636 (SCL-DR-64-131) CARRIER-ERASE RECORDING SYSTEM DEVELOPMENT REPORT. J. F. Barham (Sandia Corp., Albuquerque, N. Mex.). Mar. 1965. Contract [AT(29-1)-789]. 61p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

The theory of carrier-erase recordings is qualitatively explained. This includes prerecording the tape, the erasure phenomena as viewed from a magnetic transfer characteristic (B-H curve), the demodulation process and the difference between CE and true amplitude-modulated waveforms, and some discussion of noise factors. A typical data acquisition system, recorder and package hardware, with the playback and display system is described to illustrate some of the realizable results. (auth)

26637 (VESIAC-5436VU) AIRBORNE SPECTRAL RECONNAISSANCE SYSTEM FOR DETECTION OF UNDERGROUND NUCLEAR EXPLOSIONS. (Itek Labs., Palo Alto, Calif.). May 22, 1962. Contract AF33(657)-7381. 38p.

Descriptive charts, diagrams, and photographs are presented which are related to the development of an airborne spectral reconnaissance system for the detection of underground nuclear explosions. Technical aspects of the system are included. (auth)

26638 INTERMEDIATE STORAGE OF INFORMATION IN AUTOMATIC NUCLEAR EXPERIMENTS. ATOMKI (Atom Kut. Int.) Kozlemen., Melleklet, 6: No. 3-4, 1-92 (Dec. 1964). (In Hungarian)

A survey on intermediate memories and the difficulties of intermediate storage is presented, and an intermediate memory is described. (D.C.W.)

26639 DENSITOMETER FOR MEASURING DENSITIES IN RANGE OF D = 0 TO D = 6. J. Trousil (Inst. for Research, Production and Application of Radioisotopes, Prague). Czech. J. Phys., 15: 340-5(1965).

An instrument permitting measurement of the density of a photographic film in a range of D = 0 to D = 6 was designed by simply adapting a normal densitometer. The advantages of this equipment are described as well as the possibilities arising for film dosimetry. (auth)

26640 HIGH-PERFORMANCE, TRIGGERED VARIABLE PULSER USING GRID CONTROLLED MULTIPLIER OUTPUT STAGE. R. A. Thomas (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 2, 23-5(Apr. 1965). (UCRL-7476)

A pulse generator designed to produce pulses with length continuously variable from 50 nsec to 1.2 μsec, a rise time of 5 nsec for short pulses, an amplitude of 600 v (maximum) into 93 ohm, and a repetition rate of 10 sec^{-1} is described, in which a grid-controlled electron multiplier and solid-state circuitry are used. (D.C.W.)

26641 DISPLAY SYSTEM FOR USE WITH A SCANNING ELECTRON ENERGY ANALYZING MICROSCOPE. William K. Brookshier and John Gilroy (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 2, 104-10(Apr. 1965).

A display system developed for a scanning electron microscope incorporating an electrostatic energy analyzer is described, in which direct-view storage tubes are used. (D.C.W.)

26642 AN OPERATIONAL THERMAL NEUTRON IMAGE INTENSIFIER. Harold Berger (Argonne National Lab., Ill.), Wilfrid F. Niklas, and Adolph Schmidt. J. Appl. Phys., 36: 2093-4(June 1965).

A thermal neutron image intensifier is described. The intensifier tube is of the vacuum type, similar to those used for x-ray image intensification. The input target of the tube is a combination consisting of a neutron scintillator and a photoemissive layer. The imaging radiation reaching the intensifier tube is converted to light and then to photoelectrons. These electrons are maintained in an image sense and are accelerated toward an output phosphor screen. The photoelectron acceleration, along with a demagnification of the image, produces a visible image many times brighter than that which could be achieved by simple fluoroscopic methods. (C.E.S.)

26643 FREQUENCY-MODULATED AUTODYNES FOR OBSERVATION OF NUCLEAR MAGNETIC RESONANCE LINES IN SOLIDS. Gerard Bertrand (Faculte des Sciences, Paris). J. Phys., Phys. Appl. (Paris), 26: 77A-83A(Feb. 1965). (In French)

The conditions for the construction of a frequency-modulated autodyne, which does not show the parasitic amplitude modulation usually observed, are studied, as well as a system for the extension of this property to the exploration of broad NRM lines of solids. An application is made using a frequency of 14 Mc/s with a 200 kc/s sweep and a lock-in modulation of 30 c/s with a swing of ± 15 kc/s. (auth)

26644 ABSORPTION-TYPE $^{1}H\{^{14}N\}$ DOUBLE-RESONANCE SPECTROMETER. Hirotake Kamei (Electrotechnical Lab., Tokyo). Japan. J. Appl. Phys., 4: 212-17 (Mar. 1965).

An absorption (single-coil)-type, high-resolution proton magnetic resonance spectrometer (JNM-3, 40 Mc/s) was reconstructed into a double resonance spectrometer. The second r-f field at about the ^{14}N resonance frequency is supplied with a variable frequency oscillator using a Clapp circuit. A double resonance probe houses two r-f coils and a glass Dewar tube. The coil for ^{14}N resonance is of the Helmholtz type and is wound on the Dewar tube coaxially with the proton resonance coil. Nitrogen gas of the constant temperature is streamed around the sample tube, to avoid the temperature rise in the sample due to the large second r-f field supplied during the operation. The completely decoupled proton spectrum of formamide was observed, in which the fine structure expected for the 40 Mc/s spectrum was clearly resolved. (auth)

26645 THE SPIN GENERATOR. R. M. Umarkhodzhaev. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 5, 88-9(Sept.-Oct. 1964). (In Russian)

Descriptions are given of a spin generator with frequency equal to the Larmor precession frequency ω_0 without compensation scheme. The design is based on the utilization of properties of the central side band produced by magnetic field modulations. The generated frequency is 21×10^6Hz, signal/noise ~20. The working material consists of a proton containing liquid. Operational stability is from 10^{-1} to 10^{-4} sec. Experimental results showed that the generator instability is less than 10^{-7}. (R.V.J.)

Radiation Detection

Refer also to abstracts 26212, 26625, 27127, and 27160.

26646 (AD-611201) CHEMICAL DOSIMETRY OF THE USAEL 3.5 KILOCURIE COBALT 60 IRRADIATION SOURCE. Carol K. Pearce and Joseph E. Ellison, Jr. (Army Electronics Labs., Fort Monmouth, N. J.). Nov. 1964. 15p. (ECOM-2540) $1.00(CFSTI).

Results are reported on the calibration of the 3.5-kilo-Curie cobalt-60 irradiation source recently installed at USAEL, using ferrous sulfate chemical dosimetry. (auth)

26647 (AE-180) PHOTOMULTIPLIER TUBES FOR LOW-LEVEL CHERENKOV DETECTORS. O. Strindehag (Aktiebolaget Atomenergi, Stockholm (Sweden)). Mar. 1965. 25p. Dep.(mn).

Tube backgrounds of several 2-inch photomultiplier types having S11, 'S', S13, and S20 cathodes are compared by measuring signal and background pulse height distributions at pulse heights corresponding to a few photoelectrons. The reference signal is generated by means of a β source and a plexiglass radiator. It is found that comparatively

good results are obtained with selected tubes of the EMI types 6097B and 9514B, having equivalent dark current d-c values down to 10^{-12} input lumens. Special interest is devoted to the correlation between the measured tube backgrounds and the dark current d-c values of the tubes, as a good correlation between these parameters simplifies the selection of photomultiplier tubes. The equivalent dark currents of the tested tubes extend over the range 10^{-12} to 10^{-9} input lumens. Although the investigation deals with photomultiplier tubes intended for use in low-level Čerenkov detectors, it is believed that the results could be valuable in other fields where photomultiplier tubes are utilized for the detection of weak light pulses. (auth)

26648 (AECL-2245) A PUSH-THROUGH CONTAMINATED CLOTHING MONITOR. [Atomic Energy of Canada Ltd., Chalk River (Ontario)]. Feb. 1965. 13p. Dep.; $0.50(AECL)

A monitor designed to detect low levels of β contamination on laundered clothes is described. It is provided with background compensation and can detect 4 nC of strontium-90/yttrium-90 spread uniformly on coveralls with background exposure rates up to 150 μR/hour. If the background is expected to rise to 5 mR/hour the sensitivity must be reduced to 30 nC of strontium-90/yttrium-90. Twelve garments can be monitored in one minute. (auth)

26649 (BNWL-14) INITIAL OPERATING CHARACTERISTICS OF REGENERATING IN-CORE NEUTRON CHAMBERS. W. L. Bunch and M. R. Wood (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1965. Contract AT(45-1)-1830. 14p. Dep.; $1.00 (cy), 1(mn) CFSTI.

The regenerating coating material in the in-core neutron flux detecting chambers is 89.8% ^{234}U and 10.2% ^{235}U. In the employed reactor flux environment, a "useful" lifetime of approximately 5×10^{21} n cm^{-2} is expected, as calculated under the arbitrary criterion that sensitivity remain within 10% of the median value established. Gamma sensitivity of the chambers was measured to be approximately 8×10^{-13} amp per R hr^{-1}, in agreement with design calculations. Neutron sensitivity of the two chambers differed by a ratio of about 3:2 because of differences in the amount of material in the sensitive coating. Although neutron sensitivity has not been established accurately, it was found to approximate the design intent of 1×10^{-16} amp per n cm^{-2} sec^{-1}. A dynamic range of five decades was available during the initial startup of the reactor after installation of the chambers. After an integrated exposure of about 2.5×10^{19} n cm^{-2}, the dynamic range of the chambers during startup was still in excess of four decades. A continuing investigation of operating characteristics of the chambers as a function of exposure in the reactor environment is in progress to establish the merits of regenerating material in this application. (auth)

26650 (CEA-R-2717) LIDIAM — LIAISON DIRECTE D'UNE CALCULATRICE AUX APPAREILS DE MESURE DE PHOTOS DE CHAMBRE A BULLES. (Lidiam — Direct-Link Computer for the Photo Measurements Apparatus of a Bubble Chamber). Bernard Deler (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Dec. 1964. 15p. Dep.(mn).

The treatment of bubble chamber pictures can be considerably improved by connecting conventional measuring machines to a small computer providing continuous control of the later as well as the immediate detection of errors and their immediate correction. The computer also performs first processing of the measured data. In addition the system described improves the effective yield of each apparatus and facilitates the control of the data. A description is given of the apparatus and of some future extensions. (auth)

26651 (CEA-R-2768) LE DOSIMETRE CALORIMETRIQUE CALVET. (The Calvet Calorimetric Dosimeter). Jean-Rene Puig and Fulvio Romano (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Mar. 1965. 31p. Dep.(mn).

A description is given of a dosimeter based on the conduction calorimetry principle, and designed to operate in swimming-pool type nuclear reactors. The properties of the apparatus are as follows: (1) the measurement is independent of the specific heat of the calorimetric elements; (2) each calorimetric element is fitted with an electrical calibration; (3) the apparatus is made up of two independent calorimetric elements; (4) the nature of the calorimetric elements makes it possible to analyze the radiation received; (5) the measurable intensities of the absorbed radiation vary from 4 to 4,000 M/rads per hour; (6) the sensitive part of the apparatus is fitted inside a cylinder 5 cm high and 2 cm in diameter. One pre-production unit made up of graphite and beryllium cores has been tried out in the reactor Siloe with radiation intensities of about 1 to 2 watts per gram. It absorbed an accumulated dose of 1.2×10^{12} Rads without any weaknesses appearing. (auth)

26652 (CLOR/IBJ-II-33) COUNTING-RATES REPRODUCIBILITY AND ACCURACY IN MEASURING ALPHA ACTIVITY WITH Si(Au) SURFACE-BARRIER DETECTORS. J. Roman, M. Slapa, and J. Chwaszczewska (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1964. 33p. Dep.

The behavior of the silicon surface-barrier detectors, under ordinary laboratory conditions, in measuring alpha activity was investigated. The operating characteristics taken both with voltage and with charge-sensitive preamplifiers are given. It was investigated, whether any counting errors can be stated in addition to the statistical fluctuations theoretically expected, when measuring alpha activity with an accuracy of 0.3%. Also the drift of counting rates in long-term operation was examined. The effects of changes in temperature, fluctuations of detector bias, exposure during storage to daylight, and rapid changes in counting rates were considered. The results obtained show that the discussed detectors are well suited for low-level counting, where long-term stability is required. The high accuracy and reproducibility of counting rates make them promising in absolute measuring methods. The useful life time of the detectors is limited by the radiation damage in the silicon. The changes in the operating characteristics were studied and relevant results are presented. (auth)

26653 (EGG-1183-2016) THERMOLUMINESCENT DOSIMETER AS THE GAMMA COMPONENT OF A NUCLEAR ACCIDENT DOSIMETER. John S. Handloser (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). [196?]. Contract AT(29-1)-1183. 15p. (CONF-650302-4). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna.

The desirable characteristics for gamma accident dosimeters are reviewed. Two existing CaF thermoluminescent dosimeter systems are described and their application as accident dosimeters explained. (W.L.G.)

26654 (EUR-2248.e) THE CORRECTION FOR FOIL ABSORPTION IN 4π-COUNTING. W. van der Eijk (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1965. 31p. Dep.(mn).

Experimentally determined corrections for the foil absorption in 4π counting are presented for several radionuclides in current use. A discussion of the precision and the limits of applicability as well as a short discussion of the theoretical aspects of the problem are included. (auth)

26655 (IAE-697) KORREKTSIYA VREMENI PROLETA NEITRONOV V MNOGOSEKTSIONNOM DETEKTORE. (Correction for Flight Time of Neutrons in a Multisection Detector). O. G. Bespalov, T. A. Mostovaya, and A. P. Tsitovich (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1964. 8p. Dep.(mn).

A correction method is suggested for neutron time-of-flight measurements in multisection fission detectors. The corrections are achieved by a system of controlled delay lines. (tr-auth)

26656 (IAE-699) MNOGOMERNOE VKHODNOE USTROISTVO 2048-KANAL'NOGO ANALIZATORA. (Multimeasuring Input Device for a 2048-Channel Analyzer). S. K. Sotnikov and A. P. Tsitovich (Institut Atomnoi Energii,

Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1964. 19p. Dep.(mn).

An improved intermediate memory device on the potentiometer of a 2048-channel magnetic drum analyzer is described. The device is capable of operating with time-channels up to 0.2 msec. The delay scheme and the adjustment to a linear accelerator start up are also described. The time-measuring programming in (n,γ) studies is accomplished by an auxiliary long duration memory device. An attachment for two-dimensional measurements with a programmed adjustment on the magnetostriction delay line is described. (R.V.J.)

26657 (IDO-12031) LATENT IMAGE FADING IN PERSONAL NEUTRON MONITORING FILM AT THE NRTS. John P. Cusimano (Idaho Operations Office (AEC), Idaho Falls. Health and Safety Div.). Apr. 1963. 18p. Dep. (mn); $1.00(cy), 1(mn) CFSTI.

Mylar-wrapped and factory-wrapped Kodak NTA films were exposed to a fast neutron source and processed 1 to 42 days after exposure. Particle tracks were read and statistical analysis of the results carried out. The results indicate that latent image fading of proton tracks does not occur in NTA film under the experimental conditions (controlled temperature and humidity). The measured exposure values were consistent with actual exposures. (D.L.C.)

26658 (SZS-6) AUSWERTUNGSMETHODEN BEI DER FILMDOSIMETRIE VON RÖNTGEN- UND GAMMASTRAHLUNG IM ENERGIEBEREICH VON 10 kev–2 Mev UNTER BESONDERER BERÜCKSICHTIGUNG DER FILTER-ANALYSE. (Evaluation Methods by Film Dosimetry of Roentgen and Gamma Radiation in the Energy Region of 10 kev–2 Mev Under Special Consideration of Filter Analysis). Antje Larssen (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany). Dec. 1964. 32p. Dep.(mn).

The problems in film dosimetry of x and gamma radiation in the energy range from 10 kev to 2 Mev are presented and discussed. Especially, the conditions are derived in replacing the well-known filter analysis from Dresel by a more simplified one. Instead of homogeneous radiation, the radiation used in medicine is employed for calibration. Thereby, expense of work is reduced in extensive routine personnel dose control. Moreover, criteria are derived to select films which nevertheless must be evaluated by the method of Dresel. Such cases are very seldom in routine control. Furthermore, the limits of energy-independent evaluation using an additional filter of 0.7 mm Pb are shown. The evaluation of exposures with both conventional x rays and gamma rays of high energy is presented. The influences of oblique incident radiation, varying parameters of development, and fluctuations of emulsions are briefly discussed. (auth)

26659 (JAERI-1069) THE CONSTRUCTION AND PERFORMANCE OF JAERI MECHANICAL NEUTRON VELOCITY SELECTOR. Koichi Okamoto (Japan Atomic Energy Research Inst., Tokyo). Aug. 1964. 34p. (In Japanese) Dep.(mn).

The JAERI mechanical neutron-velocity selector has been constructed to be used in combination with the JAERI neutron crystal monochromator in order to remove the higher order contaminant from the Bragg beam. This selector is of the helical slot type. While its resolution is approximately 26%, it is designed to have high transmission as 75%. Built of KR Monel alloy, 80 helical slots are milled on the rotor with a helical pitch of 10 meter, and the effective length of the rotor is 44 cm and the diameter 18.6 cm. The rotor is driven by a 400 watt d-c motor, the rotation speed is stable within 0.1%, and the speed is continuously variable from 1,500 to 15,000 rpm, corresponding to an energy range from 0.0003 to 0.03 ev. The total neutron cross section of dysprosium in this energy range has been measured by this velocity selector. (auth)

26660 (JINR-E-1855) RECENT ADVANCES IN BUBBLE CHAMBER TECHNIQUE. H. Filthuth (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). [1965]. 53p. (CONF-550-89). Dep.(mn).

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

Developments in bubble-chamber techniques, equipment, and capabilities are surveyed. Experimental results are noted. (T.F.H.)

26661 (JINR-P-2057) TELEVIZIONNYI SPOSOB IZMERENIYA KOORDINAT TREKOV CHASTITS PRI AVTOMATICHESKOI OBRABOTOKE FOTOPLENOK S TREKOVYKH KAMER. (A Measurement of Coordinates of Particle Tracks by Using Television Method in the Automatic Processing of Track Chamber Photographs). V. N. Shkundenkov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1965. 16p. Dep. (mn).

A television method of measuring the coordinates with a special system of check lines is described. It allows one to limit the influence of the raster distortions both along the line and along the frame scannings. A calculation is given of a possibility of applying the described circuit for the processing of the spark chamber photographs. (auth)

26662 (KFK-257) SCHNELLER VORVERSTÄRKER 100 K-EKP. (The Fast Preamplifier 100 K-EKP). Joachim Kind (Kernforschungszentrum, Karlsruhe (West Germany). Institut für Experimentelle Kernphysik). Nov. 1964. 9p. Dep.(mn).

The characteristics, circuit, and performance of a fast preamplifier that can be used for fast signals from semiconductor detectors are reported. (J.S.R.)

26663 (MURA-708) MAGNETIC FIELD CALCULATIONS SUITABLE FOR A HEAVY LIQUID BUBBLE CHAMBER MAGNET. F. J. Kriegler and S. C. Snowdon (Midwestern Universities Research Assn., Stoughton, Wis.). Feb. 23, 1965. 16p. Dep.; $1.00(CFSTI).

A simplified method of calculating two-dimensional magnetic fields including the effects of finite permeability in the iron is presented. The geometry chosen is that of an H magnet and is suitable for considerations of magnetic fields desired in connection with heavy liquid bubble chambers. (auth)

26664 (NASA-TM-X-51623) PULSE HEIGHT ANALYZER AND COMMUTATING CIRCUITS FOR IMP E vs. dE/dx NUCLEAR ABUNDANCE EXPERIMENT. S. Paull, C. Cancro, P. Janniche, and N. Garrahan (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct. 4, 1963. 30p. (X-631-252; N64-19590). CFSTI.

The E vs dE/dx experiment for the IMP spacecraft (S-74) is comprised of four cards containing instrumentation and electronics. A cosmic-ray scintillation telescope on one card furnishes analog information on three output channels. Pulse-height analyzer and coincidence logic circuits on two electronics cards change the analog information to digital form, according to certain coincidence logic. A Geiger counter cosmic-ray telescope on the fourth card furnishes digital information to commutating circuits on one of the electronics cards, and from this card outputs from the pulse-height analyzer and commutating circuits are fed to the IMP spacecraft telemetry system. The pulse-height analyzer and coincidence logic and commutating circuits are described. (auth)

26665 (NP-14875) TESTS ON A p-n JUNCTION SEMICONDUCTOR RADIATION DETECTOR AND A LOW NOISE AMPLIFIER SYSTEM. M. De Carolis, G. Hannestad, and L. Svansson (European Company for the Chemical Processing of Irradiated Fuels, Mol, (Belgium)). Sept. 1964. 36p. (ETR-168). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A series of measurements was taken on two surface barrier semiconductor detectors, a charge sensitive preamplifier, and a low noise amplifier assembly. The purpose of these tests was to find the efficiency of all the equipment and the difference existing between two detectors of different resistivity, and to investigate the optimum conditions for the electronic equipment. A short summary is given on how a semiconductor detector works with its amplifier system. (auth)

26666 (NYO-1726-14) DEVELOPMENT OF SMALL IN VIVO β-RAY DETECTORS AND THEIR DIAGNOSTIC APPLICATIONS. EVALUATION PROGRAM AT NEUROSURGICAL CENTERS OF BRAIN TUMOR LOCALIZATION UNITS USED AT OPERATION WITH P^{32}. Progress Report, May 15, 1963–May 14, 1965. Bertram Selverstone (New England Medical Center Hospitals, Boston, Mass. and Tufts Univ., Boston, Mass. School of Medicine). Contract AT(30-1)-1726. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Progress is reported in the development and testing of small G-M tube β detectors for the in vivo localization of brain tumors after the administration of ^{32}P. Results of clinical evaluation of the equipment are included. (C.H.)

26667 (ORINS-49(p.111-26)) DETECTING AND LOCALIZING RADIOACTIVITY IN PATIENTS. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.).

The development of a series of 3 whole-body counters allows whole-body γ retention counts to be made over the entire range of activities from therapeutic levels to natural body background. Counting procedures and sensitivities are described. The use of thermoluminescent dosimeters to measure the dose to patients during whole-body γ irradiation is discussed. Design features are described for a whole-body scanner that uses a scintillation detector mounted under the patient's bed. The electronic system includes both multidot and photoscan recording equipment. (C.H.)

26668 (RCN-34) FOCUSSING OF A TRIPLE-AXIS NEUTRON SPECTROMETER WITH THE AID OF A GRAPHICAL METHOD. J. Bergsma and C. van Dijk (Reactor Centrum Nederland, The Hague (Netherlands)). Feb. 1965. 23p. Dep.(mn).

The theory of focusing a triple-axis neutron spectrometer for the study of inelastic neutron scattering in crystals is discussed. The conditions for focusing the monochromator and analyzer crystals are formulated analytically. By using this formulation a graphical method is developed for evaluating the focusing parameters for the spectrometer. The experimental limitations for focused operation of the triple-axis spectrometer are indicated. (auth)

26669 (TID-21844) CALIBRATION OF A SILICON SURFACE-BARRIER DETECTOR TO READ NEUTRON DOSE INDEPENDENT OF INCIDENT NEUTRON ENERGY (thesis). Alfred John Ahlquist (Washington Univ., Seattle). 1965. 42p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A Si surface-barrier detector with a LiF foil was calibrated for reading neutron doses independently of both the neutron energy and the associated gamma radiation. The 10-inch polyethylene sphere, used to moderate the neutrons, was found to give a response similar to the inverse of the Radiation Protection Guide curve. The sensitivity and lifetime of the detector are discussed. (D.L.C.)

26670 (UCRL-7798) ESTIMATION OF COUNTING RATES FROM PERIODIC OBSERVATIONS OF A SMALL SET OF BINARY SCALERS. J. Stevens (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 25, 1965. Contract W-7405-eng-48. 16p. Dep.; $1.00(cy), 1(mn) CFSTI.

The counts received by a radiation detector located on a space satellite were stored in a small set of binary scalers. The number of counts stored in these scalers was read out once per second for eventual transmission to earth via telemetry. This information was then used to determine counting rates as a function of location in space. The number of scalers used was too small to contain all the counts which could be received during the time interval between successive samplings of the scaler contents. This posed the problem of estimating the probability that the scalers had been filled, had automatically reset to zero, and had begun storing counts again during the interval between samplings. Because of telemetry limitations it was not possible to sample the condition of all the binary scalers. Only the information stored in the last few scalers is known, and hence there is the problem of estimating how many counts are stored in the preceding scalers. A technique for analysis of the data is presented, together with flow charts for a FORTRAN code using this technique. (auth)

26671 (CEA-tr-A-1822) DETERMINATION DU FLUX INTEGRAL (DE NEUTRONS) A L'AIDE DE DETECTEURS AU NICKEL ET AU TITANE. (Determination of Integral Flux (of Neutrons) by Means of Detectors of Nickel and of Titanium). W. Koehler (Technische Hochschule, Munich (West Germany)). Translated into French from German report FRM-61. 1964. 38p. Dep.(mn); $3.60(fs), $1.34 (mf) JCL.

After a discussion of the possibilities of determining experimentally the integral flux of fast neutrons with activation detectors, the actual experimental results based on the threshold reactions $^{58}Ni(n,p)^{58}Co$ and $^{46}Ti(n,p)^{46}Sc$ were exposed to the light of some irradiation tests. This type of measurement requires particularly severe conditions with respect to the purity of the detector materials, and the tests were made on substances of different origin. If characteristic controls (γ spectrum, half lives, etc.) are not made, it is impossible to effect activity measurements with the substances used. By representing, as a function of the integral neutron flux, the variations of the physical characteristics of the samples irradiated, a much better agreement (even in the case of modification of the configuration of the nuclei) is obtained than in those represented as a function of the length of irradiation. Apart from these experimental values, the cross sections of flux distribution in the core of reactors moderated with light water are indicated for the reactions cited. (tr-auth)

26672 RADIOLOGIC TECHNICS AND INSTRUMENTATION FOR MEDICAL RESEARCH AND DIAGNOSIS. Am. J. Med. Electron., 3: 201-9(July-Sept. 1964).

The development of specialized radiation detectors and counters for use with radioisotopes in various diagnostic techniques is reviewed. The examples cited include the development of an α spectrometer which can measure and identify materials of very low specific activity and can accept a radioactive sample dispersed over an area of 1800 cm^2; development of a combined radioactive source and exposure chamber which permits accurate controlled exposure of test animals and other specimens to γ intensities which can be automatically varied in discrete intervals up to 1000 R/hr, and yet is no longer than a television console with less than 2 mR/hr at the surface; β-γ counters which are small enough to be mounted on catheters for insertion through a blood vessel into the heart; and strings of β counter tubes for locating occult bleeding sites in the gastrointestinal tract. Localization of brain tumors, by differential uptake of ^{32}P, required the development of a suitable miniature Geiger-Mueller counter which could be used as an accurate brain probe. A halogen self-quenched detector was designed to replace early type tubes. Miniaturized end window probes for ophthalmology and use with ^{32}P are described. One such probe consists of a miniature tubular counter bearing a thin end mica window. Technics were worked out for splitting ultrathin ruby mica windows (1.4 to 2.0 mg/cm^2) and then fusing them permanently to the tube cathode. The ^{32}P diagnostic test utilizing these detectors has proved to be valuable in the differentiation between malignant and benign ocular conditions. Study of lesions in the posterior choroid, however, was prevented by the inability to position the probe against the posterior sclera. To overcome this a long curved probe was designed bearing a thin, rugged, mica window pancake type of detector to permit a transconjuctival approach to posterior segment lesions. A detector for location of a gastric bleeding site, using ^{32}P-labeled red cells, is described which consists of a long swallow tube containing 16 to 25 minute Geiger counter tubes spaced at intervals of 4 to 6 in. along the entire length. The electrical output from each individual tube is brought out separately to an electronic pulse integrator recorder which continuously indicates and records the simultaneous outputs from the individual counters. The need for smaller β-γ detectors for in vivo measurements prompted design of a completely new Geiger tube employing an unconventional parallel plate geometry. With this design it was possible to produce detectors varying in dia from 0.04 to 0.06 in. and as short as $\frac{5}{8}$ in. The 0.060-in. dia

tube passes freely through the inner bore of a No. 14 surgical hypodermic needle, permitting investigators to implant detectors (connected to a pliable cable and enclosed in an impervious sheath) directly into tissue. (BBB)

26673 ALPHA-CONVERSION ELECTRON COINCIDENCE METHOD FOR MEASURING THE ABSORPTION IN SPECIMENS BY 4π-α COUNTING. F. Verdaguer, C. E. Granados, and F. Sagastibelza (Junta de Energia Nuclear, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 40: 141-6(July-Aug. 1964). (In Spanish)

An alpha-internal conversion electron coincidence method is described, which is useful in standardization of alpha-emitting nuclides, the gamma spectra of which are not well known and show strong internal electron conversion. The accuracy of the method is discussed, and its validity is checked against a ^{241}Am solution internationally calibrated. (auth)

26674 A FAST NEUTRON SPECTROMETER BY THE TIME-OF-FLIGHT METHOD. Yu-hao Lee and Yin-chuan Yang (National Tsing Hua Univ., Taiwan). Chinese J. Phys. (Taiwan), 2: 57-62(Oct. 1964).

As an accessory to the Tsing Hua 3-Mev Van de Graaff accelerator, a fast neutron spectrometer using the time-of-flight method was designed and calibrated. The charged particle beams were pulsed by the post-acceleration chopping technique with a 3.5-mc, 10-kv p-p potential difference applied to a pair of deflecting plates. Neutron pulse widths from 4 to 8 mμs were obtained with flight paths between 1.0 and 3.0 m. The neutron energy span was 1.0 to 16.8 Mev. The linearity was better than 4%. A time resolution of 5 to 12% and an energy resolution of 10 to 24% were obtained. Samples of Fe, Al, Cu and Zn were also used for calibration of inelastically scattered neutrons. (auth)

26675 USE OF MINIATURE GLASS ROD DOSIMETERS IN RADIATION ECOLOGY. Stephen V. Kaye (Oak Ridge National Lab., Tenn.). Ecology, 46: 201-6(1965).

A system is discussed for radiation dose measurements in ecological studies with 1 × 6 mm silver-activated metaphosphate glass rods. The miniature size of the dosimeters, their low cost, simplicity of use, and wide range of sensitivity make them especially well suited for use in radiation ecology. The system measures radiation dose by the principle of radiophotoluminescence, whereby ionizing radiation entering the glass matrix reduces ionic silver to its ground state. This change is directly proportional to dose and is easily measured in a fluorometer which can be calibrated to give the actual dose that was received by the rods. Two important radioecological applications are the measurement of exposure, and the measurement of absorbed dose in media of interest such as tissue, soil, and water. Air exposure can be measured at particular locations around gamma irradiation facilities or above an infinite plane source (radioactive fallout on soil or radionuclides mixed with soil). Glass rods used to measure the exposure above the radioactive White Oak Lake bed showed that the exposure rate at five feet is reduced to only one half of the dose rate at the soil surface. Cotton tagged with glass dosimeters on White Oak Lake bed had an absorbed dose rate of approximately 2.8 rads/day in mid-June of 1962, but the dose rate decreased to 1.5 rads/day by mid-December. This decrease in dose rate was attributed to the gradually rising water table which filtered low energy photons and caused a corresponding decrease of the dose rate above the soil surface. The miniature fluorods were successfully implanted in acorns, in and on living plants, and in soil. Many other applications are possible in radiation ecology including the use of glass rods to monitor wildlife. (auth)

26676 FAST FEEDBACK STRETCHER. P. F. Manfredi and A. Rimini (CESNEF, Milan). Energia Nucl. (Milan), 12: 280-2(May 1965).

A fast feedback stretcher is described, which accepts pulses whose width is larger than 20 ns. The amplitude range is 0–4 v. For input pulses higher than 100 mv the differential linearity is better than ±1.5%. (auth)

26677 STANDARDIZATION IN THE FIELD OF NUCLEAR APPARATUS. J. Auzouy. Energie Nucl., 7: 17-24 (Jan.-Feb. 1965). (In French)

The elaboration of standards in nuclear energy was entrusted to the Study Committee 45 of the International Electrotechnic Commission. Electrical measuring apparatus used in connection with ionizing radiation is considered. The problems encountered, especially due to the rapid development of apparatus in the nuclear field, and the results obtained are described in this article. The structure and the activities of the committee are given. (auth)

26678 SPARK CHAMBERS IN HIGH ENERGY PHYSICS. Arthur Roberts (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 2, 75-81(Apr. 1965).

The properties, triggering systems, and operating modes of spark chambers are briefly discussed, together with data acquisition and processing. The merits of spark chambers in relation to bubble chambers are also considered. (D.C.W.)

26679 GAMMA-RAY SPECTROSCOPY IN THE UPPER ATMOSPHERE USING A BALLOON-BORNE DETECTOR. Philip F. Gustafson (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 2, 82-7(Apr. 1965).

A system for gamma spectroscopy in the upper atmosphere is described, in which the detector is a CsI(Tl) crystal enclosed in scintillating plastic. Some results obtained with the system are discussed, showing the feasibility of measuring the composition and concentration of nuclear test debris at high altitudes. (D.C.W.)

26680 PROGRESS IN THE APPLICATION OF SEMICONDUCTOR DETECTORS TO NUCLEAR PHYSICS EXPERIMENTS. H. M. Mann (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 2, 88-98(Apr. 1965).

The selection of a detector for a particular experiment is briefly discussed, together with experiments in which phosphorus-diffused silicon detectors and lithium-drifted germanium detectors were used. The performance and areas of applicability of these detectors are considered. (D.C.W.)

26681 QUARTZ DOSIMETERS AND GLASS PHOSPHATE DOSIMETERS. R. W. Hawley (R. A. Stephen and Co., Ltd., Mitcham, Eng.). Ind. At., 9: Nos. 1-2, 87-90 (1965)

The design and characteristics of quartz and phosphate glass dosimeters are described. (J.S.R.)

26682 APPARATUS FOR RADIATION DETECTION. Helge Bergh (Noratom, Oslo). Ind. At., 9: Nos. 1-2, 91-3 (1965). (In French)

Radiation monitoring devices for fallout, air radioactivity, liquids, and environmental activity are briefly described, with an indication given of their range of applicability. (J.S.R.)

26683 EFFECT OF ELECTRIC BIAS ON THE LUMINOSITY OF A MAGNETIC BETA SPECTROMETER. Yu. A. Andreev and I. M. Beskrovnyi. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 172-6(Jan. 1965). (In Russian)

The influence of the focusing effect of electric bias of the source on the luminosity of a magnetic β spectrometer is discussed theoretically. With the assumption of a point source and an infinite entrance plane it is found that a 4 kv bias on a source of 10 kev electrons changes the effective luminosity by less than 0.2%, i.e., the effect is quite negligible. The distortion of the field by the source holder and the side walls, however, leads to a much greater effect. The effect of these factors was determined by measurements in an electrolytic bath, and it was found that by appropriate design of the source holder the focusing effect of the bias field can be considerably reduced. A cylindrical source holder is described which is particularly advantageous in this respect. It is concluded that method of varying

the bias on the source can be successfully employed for precision measurement of conversion electron spectra. (ATD)

26684 SETUP EMPLOYING A LARGE DOUBLE-FOCUSING SPECTROMETER FOR STUDYING β-γ COINCIDENCES. Yu. A. Andreev, E. A. Gorbatov, O. D. Kovrigin, and G. D. Latyshev. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 177-80(Jan. 1965). (In Russian)

A setup for β-γ coincidence investigations is briefly described. The β channel employs a high transmission version of a double focusing $\pi\sqrt{2}$ magnetic beta spectrometer. The radius of the equilibrium orbit is 50 cm, the pulse resolution is 0.25%, and the transmission is 0.7% of 4π. Two Geiger-Mueller counters in coincidence were employed to record electrons with energies below 100 kev, and a plastic scintillator for higher energy electrons. The γ channel employs a 2×3 cm^2 NaI(Tl) crystal scintillator with a photomultiplier located in the magnet gap. Several means for compensating the magnetic field in the vicinity of the photomultiplier were tried, and rectangular windings similar to Helmholtz coils were found to be satisfactory. Turning on the compensating field displaced conversion lines by less than 0.2%. The instrument was tested by recording the K conversion spectrum of ^{166}Gd, and the curves obtained are shown. The setup is currently being employed to identify K x rays by observing their coincidence with conversion electrons of different energies. (ATD)

26685 AUTOMATIC MEASUREMENT OF CONVERSION ELECTRON SPECTRA. Yu. A. Andreev, I. M. Beskrovnyi, L. I. Dragomoshchenko, G. D. Latyshev, and G. P. Chursin. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 306-10(Feb. 1965). (In Russian)

An easily constructed β spectrometer is described. Commercially available Soviet components, with or without modification, are employed wherever possible. During the operation of the instrument the β-spectrometer magnetic field is held constant, and a d-c bias on the β-ray source is varied in steps. Thus, no inverse feedback is required. The counts recorded at a given value of the bias are accumulated in one of the 99 channels available, and when the complete spectrum has been recorded it can be displayed on a cathode-ray tube or the contents of the 99 channels can be read successively on an indicator. The bias can be varied from -4 to +4 kv in steps of 20, 40, 100, or 200 v, and counting times for each bias value from 10 to 4000 sec are available. A second instrument is described which is easier to construct but is less accurate. In this instrument the bias is varied continuously and the output pulses are shifted from time to time from one recording channel to the next. (ATD)

26686 INFLUENCE OF THE GAMMA-RAY BACKGROUND ON THE ENERGY RESOLUTION OF A SPECTROMETER EMPLOYING A SEMICONDUCTOR DETECTOR. B. I. Goryachev, V. A. Kozlov, M. V. Chukichev, and B. A. Yur'ev. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 315-18 (Feb. 1965). (In Russian)

The resolution of an α-particle spectrometer employing a solid-state detector was investigated in the presence of a background of ^{60}Co γ rays. Four silicon detectors were investigated, two of the surface-barrier and two of the diffusion-drift type. The resolution was measured for the 6.066 and 6.110 Mev alphas from a ^{242}Cm source. The instrumental broadening was increased from 0.33 to 1.7% by a 3.2×10^7 cm^{-2}sec^{-1} flux of ^{60}Co γ rays when one of the surface-barrier detectors was employed, and from 2 to 13% by a 2.0×10^7 cm^{-2}sec^{-1} flux with one of the diffusion-drift detectors. The square of the instrumental broadening was an approximately linear function of the γ-ray flux, and the slope depended principally on the sensitive volume of the detector. The equation $r^2 = r_0^2 + 3.65\ bNTVE^2$ is derived for the instrumental broadening r. Here r_0 is the broadening in the absence of a γ-ray background, N is the γ-ray flux, b is the absorption coefficient of the detector material for γ-rays, V is the sensitive volume of the detector, T is the time constant of the amplifier, and E^2 is the mean square energy of the electrons released by the γ rays in the detector material. The value of the numerical coefficient was obtained with the aid of specific assumptions concerning the pulse distribution. The predictions of this equation were in agreement with the experimental data, and the equation can be employed to estimate the influence of a γ-ray background on the resolution of a semiconductor spectrometer. (ATD)

26687 A SENSITIVE STABLE PULSE-HEIGHT DISCRIMINATOR. V. A. Fedorov and G. G. Doroshenko. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 326-7(Feb. 1965). (In Russian)

The circuit is given of a pulse discriminator with great sensitivity and stability. The operation of the instrument is described briefly. The distinctive feature of the discriminator is the use of a nonlinear diode circuit in the positive feedback loop in such a way that the thermionic triodes of the univibrator remain on the linear portions of their characteristics during the stable resting phase. A threshold sensitivity of 1 to 3 mv was achieved, with a pulse length of 1 μsec and a recovery time of 0.1 to 0.2 μsec. (ATD)

26688 A NEW PHOTOMULTIPLIER WITH HIGH TIME RESOLUTION. A. G. Berkovskii and S. G. Dukor. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 328-30(Feb. 1965). (In Russian)

Characteristics of an improved FEU-36-type photomultiplier are reported. An analysis of the characteristics of FEU-36-type photomultipliers to identify the possible sources of blurring of the output showed that the main factors in determining the time resolution were the high-frequency characteristics of the anode output, especially its parasitic reactances. A coaxial output coupling was designed for the FEU-36 tube to match a 75-ohm load. The improved device was tested by flashing its cathode with pulses with a rise time of ~0.7 nsec and a length of ~1.5 nsec. The output pulses were photographed on the screen of an S1-14 high-speed oscillograph. (ATD)

26689 CHARACTERISTICS OF PHOTOMULTIPLIERS WITH TOROIDAL TYPE DYNODES AND 50 mm CATHODE DIAMETER. A. G. Berkovskii, V. G. Gusel'nikov, and S. G. Dukor. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 331-3(Feb. 1965). (In Russian)

A series of photomultipliers, employing a toroidal-type multiplier system, is being prepared, and the tubes will be issued in three types: FEU-30, FEU-63, and FEU-65, with cathode diameters of 5, 10, and 15 cm, respectively. The dynamic characteristics of the FEU-30 are discussed. The tested tubes were supplied from an adjustable voltage divider, and the electrode potentials were adjusted for maximum output pulse amplitude. This same adjustment also provided the shortest rise time. The last three dynode pairs were shunted with capacitors, and 47-ohm resistors were employed in the anode and last dynode leads to suppress parasitics. The full working area of the photocathode was illuminated by flashes from a spark source. Under these conditions 1.5-amp pulses with a 2.5-nsec rise time and 7-nsec duration were obtained in a 75-ohm load resistor. The maximum pulse amplitude for linear operation was 1.2 amp. When tested without capacitors shunting the last dynodes, the tubes showed a complete absence of parasitic oscillations, even without suppressor resistors, but the maximum pulse amplitude was only 150 mamp. The FEU-30 has a somewhat longer rise time and pulse duration than the FEU-36, but it has the advantages of a larger photocathode, higher gain (to 10^9), greater pulse amplitude, and better signal-to-noise ratio; and it is less critical in regard to adjustment. The photocathode sensitivities of 147 sample FEU-30 photomultiplier tubes ranged from 40 to 140 μamp/lm; the distribution was sharply peaked at 55 μamp/lm. (ATD)

26690 INVESTIGATIONS OF FAST PHYSICAL PROCESSES. F. Sh. Murtazin (Tashkent Polytechnic Inst.). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 87-8(1964). (In Russian)

Three experimental setups were made for studying physical processes occurring in times of 10^{-4} to 10^{-11} sec. A very interesting study is that of the primary events in the interaction of radiation with matter, in particular the measurement of the time of damping of fluorescence of different systems on activation of their

ionizing radiation. The experimental data indicate the protection mechanism and the method of energy transfer and are significant in studies of radiation processes in chemistry and biology. Knowledge of radiation effects in ion crystals is necessary for development of crystalline radiation counters, electron methods, luminescent substances, radiation dosimeters, etc. There is great interest in measuring the time of nuclear collection in the depleted region of a semiconductor counter and the lifetime of excited states. A diagram is given of coincidence equipment. A resolving time of 2×10^{-9} sec is obtained with a stilbene crystal and a ^{60}Co source. The lifetime of excited states of 10^{-8} to 10^{-10} sec was determined and agreed with values of other authors. Part of the equipment was used separately for studying the kinetics of the decay of luminescence of liquid and solid systems, (stilbene and anthracene) in times of the order of 10^{-9} sec. A stilbene phosphor–photoelectric multiplier–amplifier–oscillograph system was used for determining the length of time of the increase and decrease of impulses, etc. It can be used for measurements to 5×10^{-10} sec. (TTT)

26691 CERTAIN RESULTS FROM THE STUDY OF CORONA COUNTERS OF NEUTRONS AND THEIR USE IN REACTOR MEASUREMENTS. V. Kristov, D. Damyanov, and N. Buchvarov. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk., 10: 37-45(1962). (In Bulgarian)

Corona counters of neutrons with different electrode shapes and filled with pure argon were constructed. It is shown that a stable corona and a good working plateau may be obtained by the appropriate selection of charge resistances and argon pressure. Empirical correlations were established between the corona and the working characteristics of the counters. A long cylindrical corona counter was used as a detector of an all-wave neutron counter, with which the effectiveness of the biological shielding of the IRT-1000 Reactor in Sofia was measured. (auth)

26692 GEIGER-MÜLLER DISCHARGE PROPAGATION VELOCITIES IN ARGON–ETHANOL MIXTURES. W. P. Davis, Jr., A. M. Doyle, and W. C. Worthington (Dartmouth Coll., Hanover, N. H.). J. Appl. Phys., 36: 1979-85(June 1965).

A new method is described of measuring discharge propagation velocities in Geiger-Müller tubes utilizing the visible radiation emitted by the discharge. Propagation velocity data for argon are given as a function of pressure, overvoltage, and percentage of ethanol quenching agent. The results are in substantial agreement, not only with the available qualitative theoretical predictions, but also with previous quantitative measurements made by other techniques. (auth)

26693 PROTON TELESCOPE FOR FAST NEUTRON SPECTROMETRY. Daniel Didier, Guy Mouilhayrat, and Pierre Thouvenin (Commissariat a l'Energie Atomique, [Paris]). J. Phys., Phys. Appl. (Paris), 26: 49A-53A(Feb. 1965). (In French)

A proton recoil telescope was built, consisting of a thin hydrogenous radiator and three solid-state detectors. This apparatus is principally designed to study the neutron spectrum of the T(d,n)^{4}He, D(d,n)^{3}He and T(p,n)^{3}He reactions. This telescope is compared with a time-of-flight spectrometer. Its efficiency is approximately 10^{-6}. The resolution improves with increasing energy and is equal to 6% with 14-Mev neutrons. (auth)

26694 ELECTRONIC EQUIPMENT USED IN CONNECTION WITH AN INTERMEDIATE-FOCUSING SPECTROMETER. A. Gallmann and G. Frick (Institut de Recherches Nucleaires, Strasbourg). J. Phys., Phys. Appl. (Paris), 26: 54A-8A(Feb. 1965). (In French)

The method and the auxiliary electronic equipment which were used to study the beta decay characteristics of nuclides having lifetimes of the order of few seconds are described. The isotopes were produced inside of a Siegbahn-Slätis magnetic spectrometer by means of nuclear reactions induced by the chopped beam of a Van de Graaff accelerator. Experiments using scintillation detectors are also considered. The principle of measurement and the electronic circuits which permitted the determination of lifetimes from observation of gamma transitions cascading with beta emission are described. (auth)

26695 TRANSISTORIZED NANOSECOND TIME-TO-PULSE HEIGHT CONVERTER. Gyula Kozma and Pal Quittner. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 13: 33-9(1965). (In Hungarian)

A transistorized time-to-pulse height converter, working on the overlap principle, was built for fast neutron spectroscopy. The time-to-pulse height conversion between 5 and 135 m μsec is linear within 2%. For 14.7-Mev neutrons above 100-kev bias, the time resolution of the whole measuring assembly is $\tau = 1.6$ m/μsec, to which the contribution of the converter is less than 0.1 m/μsec. The single to coincidence ratio is 1:150. (auth)

26696 THE DOSIMETRY OF INTENSIVE SOFT X RADIATION. D. Kiessling (Institut für Physik und Physikalische Chemie der Hochpolymeren, Leipzig). Monatsber. Deut. Akad. Wiss. Berlin, 6: 768-72(1964). (In German)

The mass production of x-ray tubes emitting soft x radiation for use in medicine, biology, and radiation chemistry with a relative high radiation efficiency (>100 kR/min.) is suitable for problems in the low excitation voltage range (<60 kv). However, the types of dosimeters available are not especially suitable for use in these areas. The limits of applicability of the dosimeters available are discussed. (J.S.R.)

26697 ON THE PREPARATION OF AN ANTHRACENE CRYSTAL SCINTILLATOR AND ITS APPLICATION TO A RADIATION COUNTER. M. K. Chung and Mann Cho. New Phys. (Korea), 4: No. 1, 2-5(1964). (In Korean)

Extremely pure anthracene single crystals were grown by a method based on the technique of slowly lowering a sample tube from a furnace. Detailed descriptions of the preparation are presented. Application of the crystal to a scintillation counter is discussed. (auth)

26698 SPECIAL METHODS IN THE ANALYSIS OF CONVERSION ELECTRON SPECTRA. A. A. Bartlett (Univ. of Colorado, Boulder). Nucl. Instr. Methods, 34: 181-91 (May 1965).

A brief review is given of many of the standard methods of deducing electron momenta and energies from the study of conversion electron spectra. The errors that can arise in these determinations are discussed. With a goal of maximizing the information that can be gained from spectrometer measurements of momentum ratios, several selfconsistent methods are developed, some of which provide absolute energy determinations without recourse to the usual comparisons with electron groups of known energy. (auth)

26699 RESOLVING TIME PROPERTIES OF NaI SCINTILLATORS. J. Braunsfurth and H. J. Koerner (Universitat, Hamburg). Nucl. Instr. Methods, 34: 202-12(May 1965). (In German)

Delayed coincidence techniques were applied to investigate the resolving time properties of NaI and NaI(Tl) scintillators. Prompt resolution curves were measured as a function of energy loss in the scintillators and triggering levels of the coincidence system. Qualitatively the results can be described by the theory of Gatti and Svelto. The influence of photomultiplier noise on the time resolution is considered. The resolution obtained with 56 AVP photomultipliers and 38 mm × 25 mm NaI(Tl) scintillators was 0.08 ns (fwhm) with slopes of 90 ps for ^{60}Co energies. These values are improved by about 35% when unactivated NaI at 80°K is used. (auth)

26700 ENERGY DEPENDENCE OF PULSE HEIGHT DEFECT WITH FISSION FRAGMENTS IN A SILICON SURFACE BARRIER DETECTOR. H. Kobayashi, A. Nakamoto, and M. Hosoe (St. Paul's Univ. Rikkyo Daigaku, Yokosuka, Japan). Nucl. Instr. Methods, 34: 222-4(May 1965).

Pulse height defect of a surface barrier detector for fission fragments was estimated for each energy respectively. The pulse height defect was obtained from comparison be-

tween an integrated curve of a fragment energy spectrum after prompt neutron emission and an integrated curve measured by the surface barrier detector. A discontinuity of pulse height defect was found between the heavy and the light fragment groups. For the heavy fragment group, the pulse height defect has linear relation with fragment energy. While, for the light fragment group, the pulse height defect increases drastically at the high energy region and no linear relation was observed. (auth)

26701 PERFORMANCE OF A Au-Si SURFACE BARRIER DIODE AS A BETA RAY DETECTOR. PART II. D. R. Brundrit and S. K. Sen (Univ. of Manitoba, Winnipeg, Can.). Nucl. Instr. Methods, 34: 225-8(May 1965).

A study was made of the variation of the peak absorption efficiency of a Au-Si surface barrier detector with energy and depletion depth using monoenergetic beams of electrons and positrons. The results differ from those of previous work, in the sense that this work shows a continuous decrease of peak efficiency with electron energy mainly because of scattering out of the detector. A slight difference between electron and positron detection was observed. The positron curve shows a tail on the high energy side due to Compton scattering of the positron annihilation gamma rays. (auth)

26702 A TIME-TO-AMPLITUDE CONVERTER FOR USE WITH A PULSED ACCELERATOR. D. Maydan (Edinburgh Univ.). Nucl. Instr. Methods, 34: 229-34(May 1965).

A fast time-to-amplitude converter specially designed to be used with a pulsed beam from an electrostatic accelerator is described. The converter has a very good linearity and time resolution. Two inputs are required to operate the time-to-amplitude converter, a triggering pulse from a fast photo-multiplier and a reset pulse from a zero timing system. The zero timing system including a transistorized fast preamplifier, working in conjunction with the converter, is also described. (auth)

26703 A FAST WIDE RANGE TIME TO HEIGHT CONVERTER. H. Brafman (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Instr. Methods, 34: 239-41(May 1965).

A fast wide range time to height converter, ranging from 5 v per 50 ns to 5 v per 5 μs, is described. The time to height conversion is accomplished by charging a capacitor during the time interval between start and stop pulses. Driven by a mercury pulse generator, the circuit time resolution is 5 ps and the temperature dependence is 25 ps/10°C. A stretch- and inhibition time of 0.5 μs and 10 μs, respectively, are provided by a feedback timing circuit. Having two modes of operation, the feedback timing circuit facilitates both internal or external triggering. A zero crossing pulse shaping circuit is described. The circuit has a time shift of 100 ps for a 2-20 mamp input pulse of 5 ns rise-time. The time shift is under 100 ps for a temperature range of 10°C. (auth)

26704 A CRYOSTAT FOR SEMI-CONDUCTOR GAMMA RAY DETECTORS. C. Chasman and R. A. Ristinen (Brookhaven National Lab., Upton, N. Y.). Nucl. Instr. Methods, 34: 250-2(May 1965). (BNL-8692)

Cryostats for lithium-drifted germanium gamma detectors were designed and constructed using routine machine shop practices. These holders feature liquid nitrogen replenishment cycles of up to three weeks and activated charcoal sorption pumping which eliminates the need for external vacuum pumps. Low rates of liquid nitrogen consumption were attained by using thin walled stainless steel components in heat leakage paths, by utilizing commercially available super-insulated Dewars and by maintaining a sufficiently high vacuum. (auth)

26705 USING THE OVERLAP OF PULSES TO DETERMINE THE PULSE HEIGHT SPECTRUM. A. E. Johnsrud (National Engineering Science Co., Pasadena, Calif.). Nucl. Instr. Methods, 34: 258-60(May 1965).

A method for determining the pulse height spectrum of a train of randomly-occurring voltage pulses is described. The method of pulse height analysis entails summing up the gaps between pulses in each channel. (C.E.S.)

26706 EVALUATION OF FOCUSING COLLIMATOR PERFORMANCE. Gerald J. Hine and Herbert Vetter (International Atomic Energy Agency, Vienna). Nucl. Med., 4: 333-40(Mar. 1965).

A simple and inexpensive method is presented for the investigation of the response of focusing collimators to linear sources in air and in water. The results can be obtained either by scanning or by stationary measurements using tubes filled with solutions of radioisotopes emitting gamma rays of various energies. Besides complete isocount curve determinations, measurements can be made under conditions that simulate the air and tissue distribution for typical organ scans. (auth)

26707 NEUTRON FLUX MEASUREMENT BY FISSION TRACKS IN SOLIDS. R. L. Fleischer, P. B. Price, and R. M. Walker (General Electric Research Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 22: 153-6(1965).

Thermal-neutron doses can be simply and inexpensively measured over many orders of magnitude of integrated flux by a count of induced-fission-damage tracks in a solid with uranium impurities. Examples are given of the use of a single ordinary glass to measure neutron flux from 3×10^{14} to 4×10^{18} nvt and of the use of glass to measure the spatial variation of neutron flux. Other materials, either glassy or crystalline, allow a wide range of fluxes to be measured. (auth)

26708 ON THE WINDOWLESS MEASUREMENT OF SOFT β RADIATORS. Hans Schuerfeld and Lutz-Axel Wegner (Farbenfabriken Bayer AG, Wuppertal, Ger.). Nukleonik, 7: 74-9(Feb. 1965). (In German)

In the windowless measurement of radioactive thin-layer chromatograms by means of flow-through counters the counting yield depends on the insulation behavior of the preparation layer and its charging by positive ions. Both magnitudes are, in general, not time and/or site constant. A method was developed to eliminate the effect of the parameters on the counting yield. (tr-auth)

26709 INVESTIGATION OF A SPHERICAL COUNTER NEUTRON SPECTROMETER. Peter Filss and Reiner Bass (Johann-Wolfgang-Goethe-Universitat, Frankfurt am Main). Nukleonik, 7: 109-12(Feb. 1965). (In German)

A spherical counter neutron spectrometer was constructed according to the Bonner et al. design and was calibrated with monoenergetic neutrons in the energy range from 10 kev to 8 Mev. The corrections necessary in the measurement were described. The measured sensitivity curves showed significant variations from earlier results; the basis for these were discussed. (tr-auth)

26710 PRACTICING APPLICATIONS OF PHOTOGRAPHIC DOSIMETRY WITH RADIATION BEAMS OF DIFFERENT RADIATION LEVELS. R. Miceli, F. Bono, and F. Faccioli (Universita, Bologna). Radiobiol. Radioterap. Fis. Med., 19: 29-47(Jan.-Feb. 1964). (In Italian)

Photographic dosimetry of 55 and 180 kv x rays, ^{137}Co, ^{60}Co, and ^{90}Sr using various types of emulsion is discussed. After determining characteristics of the films, the method was used to study intensity of degradation in connection with distance, penumbra, build-up, and transmission rate in depth. Although considerable discrepancies existed between ionimetric and photographic methods in determining depth doses, there was good agreement between the two methods in air. It is concluded that the photographic method has the advantage of giving continuous visualization of phenomena, providing that technical conditions are accurate. (H.G.D.)

26711 ON THE DESIGN OF DOUBLE-FOCUSING MAGNETIC SPECTROMETERS. N. I. Tarantin and A. V. Dem'yanov. Zh. Tekhn. Fiz., 35: 186-95(Feb. 1965). (In Russian)

Focusing in the direction perpendicular to the plane of symmetry by the fringe field of a uniform-field magnetic spectrometer is discussed in detail with the finite extent of the fringe field taken into account. It is shown that the focusing effect of the fringe field is equivalent to that of two thin lenses located at the entrance and exit edges of

the field. The parameters of these lenses, as well as those of the equivalent single thick lens, are calculated for the case that the magnetic field strength decreases linearly with distance in the fringe region. The conditions for both linear focusing (reduction of the width of a broad beam of parallel particles) and angular focusing (imaging of the source) are derived. The practical solution of these equations is discussed, and charts are presented to facilitate computations. (ATD)

26712 REGISTRATORY INTENSIVNOSTI IZLUCHENII. (Radiation Rate Meters). L. S. Gorn and B. I. Khazanov. Moscow, Atomizdat, 1965. 304p.

Descriptions are given of the design, and performance of radiation detectors. Transistors instrumentation, counting tubes, magnetic elements, tunnel diodes, and other components are discussed. 245 references. (R.V.J.)

Radiation Effects

Refer also to abstract 26629.

26713 THE EFFECT OF LOW-ENERGY ELECTRON IRRADIATION OF METAL-OXIDE-SEMICONDUCTOR STRUCTURES. J. R. Szedon and J. E. Sandor. Appl. Phys. Letters, 6: 181-2(May 1, 1965).

Aluminum electrodes deposited on SiO_2 thermally grown on n-type silicon substrates were irradiated with electrons at 10 to 16 kev to a total charge of 2 to 5×10^6 coul cm^{-2}. The effective series capacitance was measured as a function of metal-to-silicon potential before and after irradiation, and the C-V and energy density of states curves are compared with theoretical curves. The results show an added positive charge as a strong function of surface potential. Measurements were also made to determine if the original condition of the interface influenced the effects of the electron bombardment, and it was found that by heating the sample for 15 minutes at 150 to 200°C, the effect of the charge was removed. (L.B.S.)

26714 HIGH STABILITY OF THIN-FILM TRIODES TO NUCLEAR-REACTOR RADIATION. L. J. D'Antonio, W. A. Gutierrez, H. L. Wilson, and C. Feldman (Melpar, Inc., Falls Church, Va.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 2, 42-5(Apr. 1965).

Two thin-film triodes, fabricated by successive vacuum deposition of metal electrodes, a semiconductor, an insulator, and a gate electrode, and which exhibit good amplifying characteristics, were exposed to steady-state reactor radiation. Samples protected by a glass cover plate during irradiation survived reactor doses of 1.3×10^{16} n/cm² (E > 0.3 Mev) and 2.4×10^{10} ergs/gm (C) without degradation. The stability in high-energy radiation environments may be attributed to the polycrystalline structure of the samples, conduction by majority carriers, and thinness of the thin-film devices. These results of steady-state irradiation substantiate previous indications from transient radiation tests which showed thin-film active and passive devices to be more stable than single-crystal devices by two to three orders of magnitude. (auth)

26715 MODIFICATION OF PHOTOVOLTAIC PROPERTIES OF p-n JUNCTIONS IRRADIATED BY 14-Mev NEUTRONS. Jean Bielle, Daniel Blanc, and Francis Cambou (Faculte des Sciences, Toulouse). J. Phys., Phys. Appl. (Paris), 26: 69A-71A(Feb. 1965). (In French)

The photovoltaic properties of silicon p-n junctions are altered by bombardment with fast neutrons. The variations of short-circuit current and open-circuit voltage observed during irradiation with 14-Mev neutrons up to an integrated flux of 10^{13} n/cm² are described. (auth)

26716 BOMBARDMENT OF THERMISTORS WITH FAST NEUTRONS. J. K. D. Verma and P. S. Nair (Saha Inst. of Nuclear Physics, Calcutta). Naturwissenschaften, 52: 82(1965). (In German)

Commercial thermistors, which were built for low resistance (about 100Ω) and low temperatures (maximum 120°C), were exposed to 14-Mev neutrons. The total neutron flux was of the order of magnitude of 10^{14} nvt. The resistance was measured, as a function of temperature, before and immediately after the irradiation. The resistance increased, but within 72 hrs the thermistors were completely recovered. (J.S.R.)

ISOTOPE TECHNOLOGY

General

Refer also to abstract 26917.

26717 (NP-15039) RADIOACTIVE ISOTOPES. (Institut za Nuklearne Nauke "Boris Kidrič," Belgrade (Yugoslavia)). [nd]. 25p. Dep.(mn).

A list is presented of radioisotopes, radiation sources, and labeled compounds for use in medical, agricultural, biological, and other tracer studies, available from the Boris Kidrič Institute of Nuclear Sciences. Material will be irradiated upon request. Prices are quoted in dollars. Order forms are included. (C.H.)

26718 (ORNL-3802) REVIEW OF RADIOISOTOPES PROGRAM, 1964. J. H. Gillette—Ingrid B. Lane, comp. (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 71p. Dep.; $3.00(cy), 2(mn) CFSTI.

Reactor-produced and cyclotron-produced isotopes, and radioisotope generators are discussed. Measurements of the half life of ^{137}Cs are reported. Distribution coefficients of Fe, In, ^{99m}Tc, ^{131}I, and ^{54}Mn between organic and aqueous phases were studied. Calculations were made on the (n,γ) burnup of ^{146}Pm in ^{147}Pm. Several computer programs for radioisotope calculations are described. Process improvements were made for the production of ^{14}C, ^{32}P, ^{133}Xe, tritium, and ^{131}I. Dissolution rates of noble metals in HCl were determined using half-wave and full-wave a-c electrolysis. The use of cesium tetraoxalate in cesium-137 processing is described briefly. Cooperative tests of a ^{60}Co-powered thrustor and a ^{90}Sr-powered thermoelectric unit are also described. The preparation of ^{99}Tc, ^{241}Am–^{242}Cm–Be, ^{192}Ir, ceramic, ^{147}Pm, ^{32}P, ^{90}Sr, and other sources was studied. Ionization chambers were calibrated for the assay of irradiated Co metal for ^{60}Co. Operations of the fission products development laboratory are described. The radioisotope safety program is described in some detail; it includes the source classification system, examination of old sources, evaluation of test methods, etc. The responsibilities and activities of the Isotopes Information Center are outlined. Isotope sales reports are included for the calendar years 1963 and 1964. (D.L.C.)

Industrial Applications

26719 (AD-607174) RESEARCH ON THE PRODUCTION OF CLINICAL RADIOGRAPHS BY MEANS OF COMPACT, LOW-ENERGY AND HIGH-INTENSITY RADIOACTIVE SOURCES. Report No. 5. Final Report, April 15, 1958–September 30, 1964. H. D. Spangenberg and M. L. Pool (Ohio State Univ. Research Foundation, Ohio). Sept. 1964. Contract Nonr 495(17). 23p. $1.00(CFSTI).

Experimental procedures were carried out to determine the feasibility of the substitution of radioactive nuclides (or isotopes) for conventional x-ray machines in the production of radiograms or roentgenograms. Radioactive nuclides with proper characteristics can be fabricated into a very small portable source. Of approximately 1,300 currently known radioactive nuclides, only 48 appeared to have properties suitable for this purpose and to be worthy of detailed study and only 11 of these meet the criteria essential for eventual clinical usefulness. The criteria chosen were that the radioactive nuclides should be readily available, be capable of easy production, have a half-life of one month or more, possess a suitable emission spectrum, and be capable of providing a high specific activity source. Some of the important properties of the 48 radioactive nuclides, used in their evaluation in accordance with the five criteria, are listed. Although no one nuclide holds first position in each of the above five criteria, nevertheless ^{125}I, ^{131}Cs, ^{144}Ce, ^{148}Sm, ^{153}Gd, ^{155}Eu, ^{159}Dy, ^{169}Yb, ^{170}Tm, ^{175}Hf, and ^{181}W reasonably satisfy the requirements for isotopic radiography. (auth)

26720 (IDO-11300(Add.)) CURRENT STATUS AND POTENTIAL OF IRRADIATION TO PREVENT POTATO SPROUTING. Addendum. George A. Freund (Western Nuclear Corp., Idaho Falls, Idaho). Feb. 1965. Contract AT(10-1)-1198. 26p. Dep.; $1.00(cy), 1(mn) CFSTI.

Progress is reported in studies on the effects of radiation processing of potatoes on sprouting, storage loss, and commercial acceptability. It is concluded that under present marketing conditions widespread use of irradiation is not likely because of its higher cost and lesser flexibility in method of application when compared to chemical inhibitors. Radiation processing shows promise for use when potatoes are re-sorted during storage. Data are included from studies on periderm formation, aftercooking darkening, and sugar buildup in radiation-processed potatoes. (C.H.)

26721 CONTRIBUTION TO THE STUDY OF THE METHODS OF CONTROL OF IRRADIATED FOOD. G. Thieulin, J. Morre, and L. Richou (Service Veterinaire Sanitaire, Paris). Ann. Nutr. Aliment., 17: B385-403 (1963). (In French)

The detection of glyoxal and malonic aldehyde in irradiated meat products using 2-thiobarbituric acid (TBA) and 3-methyl-2-benzothiazolone-4-hydrazone chlorohydrate (MBTH) was studied. Samples of beef, veal, mutton, horse, and pork were analyzed. A colorimetric method was used for the determination of the aldehydes after extraction of the substrate with trichloracetic acid. The results showed that the aldehydes could be identified and determined quantitatively. To prove that these reactions were characteristic of the presence of specific aldehydes, increasing quantities of glyoxal and malonic aldehydes were added to the normal meats. In this way the intervention of these compounds in the colorimetric compounds was determined, and the optimum activity concentration was defined. (J.S.R.)

26722 STUDY OF THE RESISTANCE TO IONIZING RADIATIONS OF GIVEN GERMS INJECTED INTO A SLICE OF PRECOOKED HAM, CANNED IN METAL CONTAINERS. G. de Saint-Aubert, L. Brunelet, P. L. Sarrazin, and P. Vidal (Laboratoire Interregional des Subsistances Militaires, Lyôn). Ann. Nutr. Aliment., 17: B405-25(1963). (In French)

The radiosensitivity of various bacteria introduced into canned ham was investigated. The experimental technique used is described in some detail; the bacteria studied were Salmonella typhi murium, Staphylococcus aureus, Escherichia coli, Streptococcus faecalis, Streptococcus faecium, Bacillus cereus, and Clostridium bifermentans. The samples were exposed to ^{60}Co γ radiation at doses up to 350 krad. The results for each germ are discussed and graphed. The γ doses necessary for the partial or total inactivation were determined for each strain. (J.S.R.)

26723 FOOD PRODUCTS SUITABLE FOR RADIATION TREATMENT. J. G. van Kooy. Atoomenergie Haar Toepassingen, 7: 40-8(Mar. 1965). (In Dutch)

Conservation by means of radiation offers good prospects for foods that are perishable such as fruit, some sorts of vegetables, and fish products. Utilization possibilities of this treatment were reviewed for vegetable products, fish and fish products, meat and dairy products. (tr-auth)

26724 THE ACCEPTABILITY OF IRRADIATED FOOD. F. J. Ley. Atoomenergie Haar Toepassingen, 7: 48-53 (Mar. 1965).

The acceptability of irradiated food with respect to possible toxicity, changes in nutritive value, and induced radioactivity is analyzed. The national and international legislation relating to irradiated food is briefly reviewed. The microbiological aspects in the evaluation of the safety of irradiated food are indicated. (J.S.R.)

26725 RADIATION SOURCES FOR FOOD CONSERVATION. W. F. Oosterheert. Atoomenergie Haar Toepassingen, 7: 54-8(Mar. 1965). (In Dutch)

In the selection of a radiation source for food conservation, the following factors play an important role: desirable character of the radiation, suitable dose, and the required production capacity. Possible sources include artificial radioactive gamma emitters and machines such as electron accelerators and x-ray machines. Data on studies and installation costs of gamma sources and machines were given. (tr-auth)

26726 POOL SOURCE HELPS DESIGN BETTER IRRADIATORS. F. C. Rice (Commercial Products, Atomic Energy of Canada Ltd., Ottawa). Can. Nucl. Technol., 4: No. 2, 30-2(1965).

A new ^{60}Co experimental chamber was built to assist in designing better and cheaper industrial irradiators. The facility will be used to study geometries for dose uniformity, to determine reliability of conveyor components, and for full-scale development work on new uses for large radiation sources. A concrete shielded room was built over a pool 20 ft. deep. An elevator raises the source out of the water for irradiation testing. Safeguards to operators and remote handling equipment are described. (F.S.A.)

26727 THE STERILIZATION OF FOODS BY IONIZING RADIATION. R. Constant (CEN, Mol, Belg.). Farmaco (Pavia) Ed. Prat., 19: 3-25(1964). (In Italian) (BLG-308)

Possible food irradiation techniques and principles of the method are discussed. Various treatments were being examined concerning the effects of increasing integrated doses on various foods. Consideration was given to the study of undesirable effects appearing in the course of irradiation, possibilities of action against these effects, comestibility, and the problem of packing. Developments in this field are described. (P.C.H.)

26728 APPLICATIONS OF THE NEUTRON MOISTURE METER, AND SOME PROBLEMS IN THE MEASURING TECHNIQUE. Hironori Ono (Central Research Inst. of Electric Power, Japan). Genshiryoku Kogyo, 10: No. 9, 33-8(Sept. 1964). (In Japanese)

The principle of the neutron moisture meter, which is usually used for soils, concretes, sintered materials, cokes and iron ores, sands, etc., is also used in a thickness gauge for steel plates (up to 40 mm), a level gauge for water and oils, a survey instrument in the petroleum industry, measurement of the calories of heavy oils, determination of the carbon-hydrogen ratio in organic compounds, determination of boron in glass, and so on. Since the reading of the neutron moisture meter corresponds to the hydrogen atoms (consequently, H_2O) in the unit volume of material, the method is useful in quality control of materials being produced under the same conditions. The interference from the variation of bulk density can be eliminated by measuring the bulk density with a γ-ray densitometer, and correcting the readings accordingly. In the actual uses of the method, however, the following problems are encountered: variation of the chemical composition of the materials, the mechanical structure of the probe, the stability of the counter or recorder circuits, the validity of the calibration curves and reference standards, and the statistical precision of the radioactive countings. The author concludes that experiences and knowledge now being accumulated may solve these problems. (NSA of Japan)

26729 APPLICATIONS OF INTENSE RADIATION SOURCES TO BIOSYNTHETIC FOODS AND MEDICAMENTS. Robert Mouton (Brussels Free Univ.). Ind. At., 9: Nos. 1-2, 65-75(1965). (In French)

The use of intense radiation sources in preparation of foods and biosynthetic medicaments is discussed with emphasis on the innocuousness and integrity of irradiated foods. The sources and irradiation installations used in food and sanitary industrial radiobiology are described. The evolution of national and international research programs is indicated. (J.S.R.)

26730 ACCEPTABILITY OF IRRADIATED FISH AND SHELLFISH: STUDIES WITH PETRALE SOLE FILLETS AND KING CRAB MEAT. Nancy Stoll and David Miyauchi (Fish and Wildlife Service, Seattle). J. Am. Dietet. Assoc., 46: 112-15(Feb. 1965).

Application of radiation pasteurization to petrale sole (Eopsetta jordani) and to king crab (Paralithodes camtschatica), both of which are of great importance commercially to the Pacific Northwest fishing industry, is reported. A comparison was made of preference responses for radiation-pasteurized products with those for comparable unirradiated (frozen-thawed) samples. Both products were γ irradiated with ^{60}Co at two dose levels, 0.2 and 0.4 Mrad, the optimal dose levels determined in previous storage studies. Following irradiation and then two and four weeks later, samples were removed from storage at 33°F and presented to a taste panel. Unirradiated frozen fillets were thawed, then handled similarly as the two irradiated samples. Preference responses were made on a 9-point hedonic scale by 83 laboratory personnel. The sole was evaluated as deep-fried fillets and the king crab meat as crab cocktail. The results for both products indicated that at each storage interval, the 0.2- and 0.4-Mrad samples received approval ratings comparable to those given the unirradiated samples. A general liking for the radiation-pasteurized products as well as for the unirradiated products was indicated. At each storage interval, no significant differences at the 5% level were found between mean scores for the 0.2-Mrad and 0.4-Mrad irradiated samples or, with one exception, between either level of irradiated sample and the unirradiated sample. The exception was at the two-week storage interval when the difference between the preference scores for the unirradiated samples and the 0.4-Mrad samples of petrale sole fillets was significant at the 5%, but this difference was not considered important in the general results of the tests. (BBB)

26731 HYDROCARBONS IN IRRADIATED BEEF AND METHYL OLEATE. Charles Merritt, Jr., J. T. Walsh, M. L. Bazinet, R. E. Kramer, and S. R. Bresnick (Army Natick Labs., Natick, Mass.). J. Am. Oil Chemists' Soc., 42: 57-8(Jan. 1965).

Sterilization of beef and other meat products by means of electron or γ radiation is accompanied by chemical changes and a characteristic flavor change which is commonly called irradiation off-odor. Some of the volatile compounds have been previously isolated from irradiated meats and a quantitative relation demonstrated between the presence of these compounds and irradiation dose. Their presence in greater amount in the irradiated product may contribute to the overall off odor sensation, but their presence, from the viewpoint of chemical composition, is not peculiar to irradiated meat. It is now shown that homologous series of n-alkanes and n-alk-1-enes are found in irradiated ground beef and that these hydrocarbons are not found in an unirradiated control sample. Data indicate their contribution to the off odor sensation. The 23 volatile compounds identified in irradiated ground beef are tabulated. The samples were irradiated at 2, 4, and 6 Mrad. All members of the homologous series of n-alkanes and n-alk-1-enes from C_2 to C_8 except ethane were found, but higher homologs were not, because of the limit of volatility imposed by vacuum distillation at −80°C. Some carbonyl and sulfur compounds were identified among the volatile compounds isolated from unirradiated ground beef, but no hydrocarbons could be found. Hydrocarbons were found only in irradiated samples. Moreover, in one fraction the relative abundance of hydrocarbons was much greater than that of other types of compounds. It is concluded that hydrocarbons are formed in beef by irradiation and that their formation in large amount contributes to the off odor. The hydrocarbons produced by irradiation of ground beef are believed to arise from the lipid, as supported by the fact that hydrocarbons are among the thermal decomposition products of soybean oil and methyl oleate and the oxidation products of safflower and olive oil. It was shown that hydrocarbons are produced upon irradiation of methyl oleate. Mass spectrometric analysis of the volatile products isolated from a sample irradiated under vacuum with a dose of 8 Mrad showed the presence of both the C_{3-7} n-alkanes and n-alk-1-enes. (BBB)

26732 EFFECT OF GAMMA IRRADIATION ON TABLE GRAPES. E. C. Maxie, K. E. Nelson, and Carol F. Johnson (Univ. of California, Davis). Proc. Am. Soc. Hort. Sci., 84: 263-8(1964).

A potential means of extending the storage and shelf life of table grapes by gamma irradiation was evaluated. The results showed that gamma irradiation has little or no practical possibilities as a substitute for SO_2 fumigation of table grapes. Taste-panel scores showed clearly that the fresh eating quality of the irradiated fruit was seriously impaired by 200 and 300 kR, even after as little as 7 days at 32°F. The damage became progressively more pronounced with time. (P.C.H.)

26733 TECHNOLOGICAL ASPECTS OF THE RADIATION PRESERVATION AND STERILISATION OF FOODS. SECTION I. PROSPECTS FOR RADIATION PRESERVATION OF FOODS IN BRITAIN. W. T. L. Neal (Ministry of Agriculture, Fisheries and Food, London). 11p (CONF-640909-2)

From International Conference on Radiation Preservation of Foods, Boston.

Developments in programs for the radiation processing of foods in Great Britain are reviewed. It is reported that plans are well advanced for the radiation processing of horse meat, intended for use as pet food, for the elimination of Salmonellae. It is pointed out that Salmonellae have been associated with outbreaks of food poisoning resulting from the consumption of spray-dried egg powder or frozen eggs, and that cocoanut, fish, and meats and fish meals used as animal feeds have been found to contain Salmonellae. The radiation processing of these foods for the elimination of Salmonellae is discussed. Other foods that offer attractive possibilities for radiation processing, for the extension of the shelf life of fresh or frozen products include fish, chicken, and meat. (C.H.)

26734 CONSIDERATION OF THE POTENTIAL PROBLEMS OF TYPE E BOTULISM IN RADIATION PRESERVED SEA FOODS. Lloyd L. Kempe (Univ. of Michigan, Ann Arbor). 11p. (CONF-640909-7)

From International Conference on Radiation Preservation of Foods, Boston.

The etiology of Type E Clostridium botulinum in human botulism caused by eating fish is discussed. It is pointed out that recent surveys have shown that Type E spores have essentially world-wide distribution in both marine and fresh water environments. Type E spores are relatively easily inactivated by heat when compared to other Clostridium botulinum spores, but recent studies have shown that a small fraction of any population of Type E spores can be heat resistant. The toxin elaborated by Type E growth can be activated by proteolytic enzymes such as are found in raw foods and in the human digestive tract so that even very low titres of Type E toxin in foods can be dangerous for man. The hydrolytic processes appear to be able to continue and ultimately destroy Type E toxin. The toxin titres in stored foods was found to vary due to proteolytic enzyme activity in the foods or toxin secretion by other bacteria. It is emphasized that foods should be tested for Type E toxin at frequent intervals or the toxin may be missed. Other problems that complicate food processing studies involving Type E are discussed. It is pointed out that Type E spores and vegetative cells are inactivated by ionizing radiation at doses less than those needed for other types of Clostridium botulinum spores but much higher than radiopasteurization doses. (C.H.)

26735 RADIATION PRESERVATION OF HAM AND OTHER CURED MEATS. Niels-Henrik Henson (Danish Meat Research Inst., Roskilde, Denmark). 9p. (CONF-640909-12)

From International Conference on Radiation Preservation of Foods, Boston.

A combination of heat treatment, in the range of 65 to 75°C at the center, followed by γ radiation, at doses of about 0.5 Mrad, was found to give good results in the processing of canned cured meat products. The doses of thermal radiation used killed vegetative cells and active spores of bacteria present in the meat and γ radiation, applied after an incubation period, destroyed heat-resistant bacterial spores, such as Clostridium. Substitution of radiation processing for part of the heat treatment led to a reduction of cooking losses in canned ham from 25 to 30% to 6 to 12% and resulted in improved texture and flavor. (C.H.)

26736 EXPERIENCE WITH A COBALT-60 IRRADIATION FACILITY INSTALLED AT ETHICON, INC., SOMERVILLE, NEW JERSEY. Albert A. Stonehill. 7p.

From Proceedings of the ANS Topical Meeting on Nuclear Power Reactor Siting, Los Angeles.

A cobalt-60 facility for the sterilization of medical products has been in continuous operation for approximately six months. A description of the facility; a record of its performance in terms of operating efficiency; the dosimetry characteristics; and actual sterilization results are reported. (auth)

26737 APPARATUS FOR EXPOSING SHEET MATERIALS TO RADIATION. (to Minnesota Mining and Mfg. Co.). British Patent 984,226. Feb. 24, 1965. Priority date Mar. 28, 1960, United States.

The apparatus described permits irradiation of entire sheets of material, including the edges, without interference from pressure caused by a mechanical constricting device. The material is held on a movable porous support spaced from a radiation source by withdrawing air from the side of the support opposite to that on which the sheet is located. The apparatus may be used with any type of intense radiation energy. (A.G.W.)

Separation and Production

See also CHEMISTRY — Separation Processes and Procedures.

Refer also to abstract 27767.

26738 (AERE-M-1374) THE ELECTROMAGNETIC ISOTOPE SEPARATOR AS A RESEARCH TOOL. J. H. Freeman (Atomic Energy Research Establishment, Harwell (England)). May 1964. Reissued Mar. 1965. 17p. Dep.; $0.60(BIS); 3s. (HMSO).

Isotope separator behavior is discussed briefly, and the possibilities of using machines such as the A.E.R.E. small sector separator as research instruments are discussed in some detail: The separator is considered (1) as an auxiliary for nuclear chemistry studies; (2) as a versatile ion gun capable of giving intense sharply focused beams for radiation damage and ion interaction studies; (3) as a controllable plasma with attached analyser for the study of the chemistry of gas discharges. It is concluded that the A.E.R.E. separator could become a valuable research auxiliary and that it might be useful for future university collaboration programs. (auth)

26739 (MIT-2249-2) DEUTERIUM SEPARATION BY AMMONIA DISTILLATION AND HYDROGEN–WATER EXCHANGE. Manson Benedict (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Jan. 15, 1965. Contract AT(30-1)-2249. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Activities in a program to determine physicochemical data on deuterium concentration by ammonia distillation and deuterium exchange between water and dissolved hydrogen are reported. The resulting data are of interest in connection with properties of isotopic mixtures. (J.R.D.)

26740 STUDY ON THE PRODUCTION OF HEAVY WATER. I. DESCRIPTION OF THE JEN-EIA INSTALLATION AT SABINANIGO. J. L. Otero de la Gandara and M. Gispert Benach (JEN, Madrid). Energia Nucl. (Madrid), 8: No. 32: 4-11(Oct.-Dec. 1964). (In Spanish)

A pilot-plant study on the production of heavy water is discussed. The Sabinanigo plant of the EIA uses the electrolytic process for the production of hydrogen for use in the production of nitrogeneous fertilizers. Supplementary installations were introduced for concentrating heavy water using the Pt-catalyzed isotopic exchange process. The pilot plant, which will have a capacity of 500 kg D_2O/year, is described, including the electrolytic cascades, feed cir-

cuits, installation for recovery of deuterium, cooling and power circuits, and control systems. (J.S.R.)

26741 PROBLEMS IN THE DOMESTIC PRODUCTION OF ISOTOPES. Genshiryoku Chosa Jiho, No. 9, 32-45(Mar. 1965). (In Japanese)

Radioisotopes were produced and distributed by JAERI for 14 nuclides since October 1964, but their use did not increase as expected. Problems, particularly in their distribution, are described and discussed. (M.C.G.)

26742 KINETICS OF ISOTOPE EXCHANGE BETWEEN HYDROGEN AND WATER VAPOR OVER NICKEL CATALYSTS. I. EFFECT OF TRANSPORT PROCESSES ON THE REACTION RATE. E. S. Nedumova, G. K. Boreskov, and M. G. Slin'ko (Mendeleev Inst. of Chemistry and Tech., Moscow and Inst. of Catalysis, Academy of Sciences, Siberian SSR). Kinetika i Kataliz, 6: 65-73(Jan.-Feb. 1965). (In Russian)

Isotopic exchange of $HDO + H_2 \rightleftharpoons HD + H_2O$ over a nickel-chromium catalyst was studied by circulation flow and other flow methods. The effects of catalyst grain size and the linear gas flow velocity were analyzed. A kinetic equation was developed for the chemical kinetics and internal diffusion. It was found that at 130°C the isotopic exchange by internal diffusion takes place with particles larger than 0.1 mm. (tr-auth)

26743 EVALUATION OF PARASITIC REMIXING IN THERMAL DIFFUSION COLUMNS. S. Raman, S. M. Dave, and T. K. S. Narayanan (Atomic Energy Establishment, Trombay, India). Phys. Fluids, 8: 896-9(May 1965).

A quasi-theoretical method to evaluate the parasitic remixing constant in a thermal diffusion column is given. The method is applied to the Saxena and Watson column measurements on neon. It is shown that calculated values of separation agree well with experimental values when parasitic remixing constant, thus evaluated, is included in the expression for separation. The agreement is better for the more realistic Lennard-Jones potential than the inverse power potential. It is found that parasitic remixing increases with pressure, though no simple power relation exists. (auth)

26744 SULZER RECTIFICATION PLANTS FOR SEPARATING D_2O FROM H_2O. M. Huber and A. Sperandio. Sulzer Tech. Rev. (Switz.), 46: 177-88(1964).

Examples of rectification plants for separating heavy water from ordinary water for final enrichment in heavy water production facilities, for reconcentrating diluted heavy water in nuclear reactor plants, and for extracting water from reactors are described. The practical applications of separating plants of this type are also discussed. (auth)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 26915 and 27304.

26745 (ANL-6988) SINGULAR INTEGRALS AND SINGULAR INTEGRAL EQUATIONS WITH A CAUCHY KERNEL AND THE METHOD OF SYMMETRIC PAIRING. Erwin H. Bareiss and Charles P. Neuman (Argonne National Lab., Ill.). Jan. 1965. Contract W-31-109-eng-38. 44p. Dep.; $2.00(CFSTI).

The method of symmetric pairing, combined with midpoint integration, is introduced for the numerical evaluation of Hilbert transforms (and the Kramers-Krönig relations) and singular integral equations with a Cauchy kernel. The method, for use on high-speed computers, is simple, reliable, and inexpensive. Numerical examples are presented. (auth)

26746 (BNL-7963) ON THE EXPLICIT CONSTRUCTION OF GENERALIZED EIGENFUNCTION EXPANSIONS. Joel David Pincus (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 23p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The generalized eigenfunction expansion of the Fourier-Mautner type for a self-adjoint operator on a Hilbert space is considered. The ease with which this type of expansion can be carried out depends on the ease with which the continuum eigenfunctions for the self-adjoint operator can be calculated. A procedure is presented for calculating the continuum eigenfunctions. The existence of the resulting generalized expansion is proven, under the sole condition that the continuous spectrum of the original operator be absolutely continuous. (T.F.H.)

26747 (COO-614-23) ICR QUARTERLY REPORT NUMBER 3. Nicholas C. Metropolis (Chicago Univ., Ill. Inst. for Computer Research). Nov. 1, 1964. Contract AT(11-1)-614. 169p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

MANIAC III engineering activities are summarized. A block diagram of the MANIAC III memory bank drawn to permit development into a cross bar system is presented for structure clarification. Information concerning two new MANIAC III instructions is included along with descriptions of new MANIAC III experiment and a proposed multi-computer system. A reference manual for the MANIAC III Algal compiler is included along with an outline for information science. Work on spark chamber and circuit development for computer-wire chamber systems based on programmed discharges added to high-voltage pulses is described. A brief summary of presentations at a seminar on error in digital computation is given. An Algal compiler to operate on the CDC 3600 computer is described. An iterative method of order $P \geq 2$ for inversion of non-regular matrices and bounded linear operators in finite and infinite dimensional Banach and Hilbert spaces is discussed. Two variants of a method for solution of the functional equation $Lu = f$, where f is a given element in a Hilbert space (H), and L is a densely defined linear unbounded operator in H which is neither symmetric nor K-symmetric are described. Comments on astronomy meetings and isophotometry of galaxy photographs are included. The presence and implications of irreversibility and co-operative effects in stellar dynamics are discussed. Comments concerning unsolved problems associated with distribution functions in astronomy are included along with an analysis of price and quantity paths which arise in joint distributed lag demand equations. (J.R.D.)

26748 (EUR-2280.f) PROGRAMMATION RELATIVE AU CALCOMP. (Programming Relating to Calcomp). P. Moinil and J. Pire (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center and European Atomic Energy Community, Ispra (Italy). European Scientific Data Processing Center)). 1965. 152p. Dep.(mn).

The set of subroutines described facilitates the utilization of the Data Plotter Calcomp (564 or 506) in scientific programs written in Fortran II or Fap and carried out on IBM 7090-7094. These subroutines prepare an output tape which is transmitted to the Data Plotter by an IBM 1401. (auth)

26749 (IS-1128) GENERATION AND TESTING OF RANDOM-NUMBER SEQUENCES. Frank S. Carlsen (Ames Lab., Iowa State Univ. of Science and Tech.). Mar. 1965. Contract W-7405-eng-82. 37p. Dep.; $2.00(cy), 1(mn) CFSTI.

Two methods of generating pseudo-random numbers in a decimal computer are described. Methods of testing the sequences of generated numbers are discussed and the two methods of generation are compared to determine which method is superior for general usage. A computer routine to generate both uniformly and normally distributed numbers is presented, with a table of 9000 three digit numbers uniformly distributed on the unit (0–1) interval. (auth)

26750 (NYO-1480-16) PROGRESS REPORT NO. 33 [ON COMPUTING AND APPLIED MATHEMATICS] FOR THE HALF YEAR, JULY 1–DECEMBER 31, 1964. Technical Summary for Tasks I and V. Robert T. Shevlin (AEC Computing and Applied Mathematics Center, New York Univ., N. Y.). Mar. 29, 1965. Contract AT(30-1)-1480. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Investigations of miniature 20-mil cores for high-speed memories are described along with developmental work on small memories with write-only time of 100 nanoseconds and nondestructive read magnetic-core modules. Work on thin-films was devoted to improvement of continuous wire plating systems. Work is also reported on design of 24-bit adder-subtractors. Summaries of work on applied mechanics and mathematics, physics, and computer operations and methods are included. (J.R.D.)

26751 (WAPD-TM-493) ROC-1—A FORTRAN PROGRAM FOR STORAGE OF EVALUATED NUCLEAR DATA. D. R. Harris, A.V. Vota, G. E. Morris, C. B. Noll, and H. Bohl, Jr. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1965. Contract AT(11-1)-Gen-14. 51p. Dep.; $3.00 (cy), 2(mn) CFSTI.

Descriptions are given of the ROC-1 and MO431 FORTRAN programs for storage, retrieval and exchange of evaluated nuclear data used in reactor studies. The ROC-1 program reads sets of evaluated nuclear data from punched cards and prepares or updates a master nuclear data storage tape which is referred to as the ROC library tape. The MO431 program prints out an edit of part or all of the information on the ROC library tape or punches the data on cards in a format acceptable as input to the ROC-1 program. Alternative storage forms for evaluated nuclear data are described and identified, and certain storage forms are recommended for efficient retrieval and use by reactor study programs. (auth)

26752 THE CASE FOR FIXED-WIRE ANALYZERS IN NUCLEAR DATA ACQUISITION. T. J. Kennett and W. V. Prestwich (McMaster Univ., Hamilton, Ont.). Nucleonics, 23: No. 5, 65-71(May 1965).

An analysis of data acquisition systems for experiments in nuclear physics is presented, which indicates that the preferred system is a large fixed-wire analyzer with magnetic tape totalizing and off-line reduction. (D.C.W.)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstracts 27735 and 27784.

26753 (AD-610502) STRUCTURAL MATERIALS FOR NUCLEAR APPLICATIONS. Monograph Series No. 58. R. M. Colton and F. J. Rizzitano (Watertown Arsenal Labs., Mass.). [1962]. 30p. (WAL-MS-58). $2.00(CFSTI).

A summary is presented of the past, present, and projected efforts required to produce stronger, lighter weight and more reliable structural materials for weapons systems. (W.L.G.)

26754 (BNL-920) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review, Volume 3, Number 1. (Brookhaven National Lab., Upton, N. Y.). Feb. 1965. Contract AT-30-2-GEN-16. 56p. Dep.; $3.00(cy), 2(mn) CFSTI.

A total of 23 reviews are presented of reports and progress reports on research relevant to liquid metals at high temperatures. Various data from the reports are plotted and tabulated. Subject and issuing organization indexes are included. (D.L.C.)

26755 (BNWL-43) ELECTRON MICROSCOPE STUDIES OF SECOND-PHASE PARTICLES IN DILUTE ALLOYS OF URANIUM. T. K. Bierlein, B. Mastel, and C. L. Corey (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1965. Contract AT(45-1)-1930. 9p. Dep.; $1.00(cy), 1(mn) CFSTI.

Transmission electron microscopy was successfully utilized to study particle-size density distributions in dilute alloys of uranium. The results of a quantitative metallographic procedure used for determining particle size-density distributions from transmission electron micrographs agree well with that derived from replica electron micrography. The increase in resolution inherent in transmission techniques permits inclusion of particles normally too small to be resolved by replica methods. (auth)

26756 (CEA-R-2762) REACTION DU NICKEL AVEC LE NITRURE D'URANIUM. (Reaction of Nickel with Uranium Nitride). Francois Anselin, Daniel Calais, Nicole Lorenzelli, and Jean-Claude Passefort (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre de Etudes Nucléaires). Feb. 1965. 21p. Dep.(mn).

The UN–Ni system was investigated in solid phase by diffusion couples UN–Ni or by mixed powders which were pressed and sintered. Studies were carried out by micrography, x rays and microanalysis with a Castaing microprobe. UN–Ni compatibility is quite good up to 600°C; beyond this temperature, diffusion zones corresponding to UNi_8 and U_2N_3 appear in the couples. One of the reactions, $3UN + 5\ Ni \rightarrow U_2N_3 + UNi_8$ or $UN + 5\ Ni \rightarrow UNi_5 + \frac{1}{2}\ N_2$, takes place from 700°C according to nitrogen pressure involved. For temperatures between 800 and 1000°C, nickel solubility in uranium nitride is 1500 ± 500 ppm by weight. (auth)

26757 (RSIC-228) THE PROCESSING AND PROPERTIES OF HASTELLOY C. J. H. Gehrke, C. M. Jackson, and F. W. Boulger (Battelle Memorial Inst., Columbus, Ohio). May 28, 1964. Contract DA-01-021-AMC-203(Z). 46p.

A compilation of available information on the properties and processing characteristics of Hastelloy C is presented for use in connection with the possible utilization of this alloy for the transport of gaseous oxygen in S-1C Saturn. The topics covered include phase relationships, hardening mechanisms, physical and mechanical properties, melting procedures, procedures for primary fabrication, bending, machining, joining, degreasing, light pickling, heat-treating schedules and atmospheres, and corrosion behavior. (auth)

26758 (TID-21852) EFFORTS TO GROW VERY LARGE BERYLLIUM SINGLE CRYSTALS FOR NEUTRON SPECTROMETERS. Final Report. James F. Kirn (Virginia Inst. for Scientific Research, Richmond). Feb. 16, 1965. Contract AT(40-1)-2860. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An attempt was made to grow large Be single crystals by the Bridgman and Czochralski techniques, for use as monochromators in neutron spectrometers. The attempt ended in failure, although it is believed that success could be attained with the Czochralski technique if surface contamination could be prevented. (D.L.C.)

26759 RARE EARTH METALS. Raisa Czerniak and Janusz Lisowski. Rudy Metale Niezelazne 10: 159-63 (Mar. 1965). (In Polish)

Information is given on the rare earth metals and their growing industrial importance. The history of the rare earth metals, their occurrence, their physical and chemical properties, methods of separation, and methods of production are discussed. (auth)

26760 URANIUM CARBIDES, NITRIDES AND SILICIDES. (International Atomic Energy Agency, Vienna (Austria)). Bibliographical Series. 1965. 180p. STI/PUB/21/14. $4.00; S84; £1.40; F.Fr. 16.-; Dm 12(IAEA).

A total of 790 references with abstracts is presented to the literature published in English, French, Russian, German, Italian, and other languages during the period 1961 to 1963. Author and subject indexes are included. (D.L.C.)

26761 RADIATION PROTECTIVE MATERIAL. Egon Rauschert, Paul Ernst Metzler, and Gottfried Paul Rauschert. British Patent 984,213. Feb. 24, 1965. Priority date June 14, 1960, Germany.

A refractory radiation-protective material consists of at least 50% by weight of an inorganic Pb compound and at least one inorganic compound of a rare earth metal. Lead oxide may be used as the lead compound. An unpurified rare earth mineral such as monazite is suitable for the rare earth compound. The material can be compressed and then sintered at an elevated temperature, using conventional methods and equipment, to form molded articles. (A.G.W.)

26762 BERYLLIA FIBER GROWTH TECHNIQUE AND RESULTANT FIBERS. (to National Beryllia Corp.). British Patent 984,294. Feb. 24, 1965. Priority date Apr. 6, 1961, United States.

Single-crystal high-strength beryllia fibers suitable for incorporating into plastics are produced by oxidizing Be metal at 1300–1800°C in the presence of a low pressure or low partial pressure of gaseous oxidant. The oxidant may be water vapor mixed with a non-oxidizing gas in an amount up to 10% by volume. A larger amount of oxidant may be used so that the BeO produced is not entirely in the form of fibers, and the fibers may be separated by mechanical means. The fibers may be in the form of whiskers with a tensile strength about 10 times that of ordinary sintered BeO or bands with a tensile strength about 7 times that of ordinary sintered BeO. (A.G.W.)

26763 PRODUCTION OF HIGH-PURITY SINTERABLE BERYLLIUM OXIDE. Carl W. Schwenzfeier and Carl S. Pomelee (to Brush Beryllium Co.). U. S. Patent 3,172,728. Mar. 9, 1965. Filed July 28, 1960.

In a process for producing BeO, beryllium sulfate is intimately mixed with an agent selected from the group consisting of urea, ammonium oxalate, ammonium acetate, and ammonium sulfate. The mixture is then calcined at 875 to 1000°C. The product is relatively friable and free from agglomerates and clinkers. It can be compacted at room temperature and subsequently sintered to substantially theoretical density. (A.G.W.)

Corrosion

Refer also to abstracts 26907 and 27768.

26764 (ANL-6979) ENGINEERING DEVELOPMENT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES.

PART 7. THE CORROSION OF NICKEL IN PROCESS ENVIRONMENTS. A. A. Chilenskas and G. E. Gunderson (Argonne National Lab., Ill.). Mar. 1965. Contract W-31-109-eng-38. 16p. Dep.; $1.00(cy), 1(mn) CFSTI.

Two types of tests were conducted: small-scale laboratory tests conducted in tube furnaces, and in-plant exposure tests. The laboratory tests were designed to examine the effect upon nickel of short-term and long-term exposures of selected gaseous environments. The in-plant tests consist of exposing specimens within various pieces of pilot-plant equipment and evaluating the corrosion rates after the completion of one or more process cycles. The results of both types of tests show: (1) Under conditions of low gas rates, where protective films can easily form, the corrosion rate of nickel by fluorine alternated with hydrogen chloride and fluorine alternated with oxygen is low (1–4 mils/yr) and is in close agreement with the rate exhibited by nickel for fluorine alone. (2) Under conditions where films form less readily (high gas velocities) or can be removed upon being formed (fluid-bed impingement), the corrosion rate is significantly higher than that under static conditions but less than the rate that would occur if no protective film formed at all. For the conditions studied, the corrosion rates in plant equipment would be expected to range between 12 and 40 mils/yr, the lower values existing in most of the components while the higher values would be expected for those components in contact with the fluid bed. (3) The corrosion rates obtained under "static" conditions for long-term exposure of two types of nickel welds were compared. The corrosion rates of welds made with nickel-200 range from 1–5 mils/yr (comparing closely with the corrosion rate for nickel plate, 1–4 mils/yr), while the welds made with nickel-61 filler metal ranged from 67–1315 mils/yr. Some evidence obtained indicates that the presence of a small amount of titanium in the nickel filler metal-61 is the cause of the high corrosion rates exhibited. (4) Specimens examined metallographically in both laboratory-scale and in-plant environments exhibited little or no evidence of intergranular attack. Several specimens from the in-plant tests have shown a few areas where apparent intergranular attack ranging in depth from 1 to 2 mils has occurred. (5) Several parameters that were thought to have a possible effect upon the integrity of the protective film were studied for their effect upon the corrosion rate of nickel. Thermal cycling of a specimen exposed to process environments had little or no effect upon the corrosion rate. Exposure of the specimen to air after each process cycle also did not greatly affect the corrosion rate. (D.L.C.)

26765 (EURAEC-1295) STUDY OF SOME OXIDATION PROBLEMS OF METALS AND APPLICATION OF IMPEDANCE MEASUREMENT METHODS TO AN INVESTIGATION ON THE RESISTANCE TO CORROSION IN AN AQUEOUS MEDIUM. Final Report. (Brussels Univ. (Belgium). Faculte des Sciences). 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract 012-63-10-TEEB. 26p. (EUR-2095). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The initial stages of oxidation of high-purity aluminum and nickel and iodation of high-purity copper were investigated. The existence of a transient nucleation stage of growth in all systems was proved. (W.L.G.)

26766 (EURAEC-1309) A STUDY OF THE STRESS CORROSION BEHAVIOR OF STAINLESS STEELS. Quarterly Report No. 1, September to December 1964. (Compagnie des Ateliers et Forges de La Loire, Paris (France). Department des Recherches). Work Performed under United States–Euratom Joint Research and Development Program. Contract 033-64-9 TEE-F(RD). 36p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Preliminary stress corrosion tests of $MgCl_2$ solutions on four grades of steel of the Cr–Ni–Mo–Cu type having a variable silicon content were performed. The purpose of the investigation is to study the effect of silicon on the stress corrosion resistance of these austeno-ferritic steels. The calculations necessary for, and the design of a bending device for the stress corrosion tests are given. (W.L.G.)

26767 (GEAP-4821) SPECIFIC ZIRCONIUM ALLOY DESIGN PROGRAM. Quarterly Progress Report No. 8. H. H. Klepfer, C. J. Baroch, R. E. Blood, J. L. Jaech, and E. A. Pickett (General Electric Co., San Jose, Calif. Vallecitos Atomic Lab.). Apr. 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 48p. (EURAEC-1375). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Progress on the evaluation of a Zr–2.0 at.% Cr–0.16 at.% Fe alloy as nuclear fuel cladding is reported. Tubing and bar stock of the Zr–2.0 at.% Cr–0.16 at.% Fe alloy were obtained by full-scale vendor fabrication. Alloy-clad fuel rods were fabricated for irradiation in the Consumers Big Rock Reactor to a target exposure of 15,000 Mwd/T. The fuel shipment was delayed by unexpectedly high weight gains after 1000 hours in a 285°C corrosion loop test made on tubing from the same ingot as that used to fabricate the fuel cladding. Other results of characterization tests including corrosion tests at 400 and 500°C were satisfactory and in agreement with previous data. Special tests to diagnose the cause of the unexpected results at 285°C are being made. Progress is reported in the study of the effect of selected fabrication variables on corrosion, hydriding, and tensile properties of the Zr–Cr–Fe alloy. (auth)

26768 (MSAR-65-62) EFFECT OF HIGH TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report No. 56, April 1965. (MSA Research Corp., Callery, Pa.). May 13, 1965. Contract AT(11-1)-765. 14p. Dep. (mn); $1.00(cy), 1(mn) CFSTI.

Progress is reported in the study on the effect of high temperature sodium on the physical properties of austenitic and ferritic steels. (W.L.G.)

26769 (N65-21626) POTASSIUM CORROSION TEST LOOP DEVELOPMENT. Quarterly Progress Report No. 6, October 15, 1964–January 15, 1965. E. E. Hoffman, ed. (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section). Mar. 12, 1965. Contract NAS 3-2547. 58p. (NASA-CR-54344). $3.00(CFSTI).

Efforts continued on the development and testing of an alkali metal corrosion test system. The operation of Component Evaluation Test Loop II, a single-phase sodium, forced-circulation loop to evaluate the EM pump, valves, pressure transducers, and other components which are being used in the Prototype Loop system, completed 2,650 hours of scheduled operation in December 1964. The highlight of this experiment was the operation of the Nb–1Zr alloy helical induction pump at approximately 2000°F. Fabrication of the Prototype Corrosion Loop progressed substantially during the last quarter. An iron titanate-coated condenser fin was substituted in place of a grit blasted condenser fin which has a substantially lower total hemispherical emittance. This change will result in an increase of the heat rejection capability of the condenser by a factor of approximately 1½. A 1000-hour test was conducted to evaluate the ability of the coated plate specimens of Nb–1Zr alloy to withstand thermal gradients and thermal cycles more severe than those anticipated during loop operation. The two refluxing potassium capsule tests which are being conducted to determine the extent of mass transfer of Mo–TZM alloy in Nb–1Zr alloy capsules have completed 1243 hours of testing at 2000°F. (D.L.C.)

26770 THE USE OF REACTIVE METALS IN THE CPI. E. R. Funk (Astro Metallurgical Corp., Wooster, Ohio). Chem. Eng. Progr., 61: No. 5, 121-6(May 1965).

The market for titanium and zirconium in corrosion resistant applications is discussed. The corrosion resistance of these metals, economics of equipment manufactured from these metals, costs of raw materials, fabrication costs, lining applications, preparation of titanium castings, and examples of fabrication are discussed. Several needs in increasing the acceptance of the reactive metals in the chemical processing industry are outlined. (M.C.G.)

26771 SURFACE TREATMENTS IN NUCLEAR MILIEU. Andre Bonnet (Parker Continental Co., Paris). Ind. At., 9: Nos. 1-2, 81-4(1965).

The passivation treatments during the manufacture of metal pieces for use in the Marcoule reactors and additional passivation treatments performed at Marcoule are briefly reviewed. Surface decontamination processes growing out of the study of surface passivation are also described. (J.S.R.)

26772 INFLUENCE OF CHROMIUM CONTENT ON CARBURIZATION OF CHROMIUM–NICKEL–IRON ALLOYS IN CARBON DIOXIDE. W. R. Martin and J. R. Weir (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 16: 19-24(May 1965). (ORNL-P-646)

The use of carbon dioxide or other gases that contain carbon dioxide as nuclear reactor coolants presents certain compatibility problems in the reactor system. One of the more important of these concerns reactions of the gas with stainless steel fuel element cladding that may introduce carbon into the steel. Results of an investigation of the carburization of Fe–9% Ni–Cr alloys in pure carbon dioxide at 600 to 800°C are presented. It is shown that the rate of carburization increases as the chromium content increases from 7 to 11% Cr and decreases sharply on further increase in chromium content to about 20% Cr. The mechanism causing carburization in these alloys depends on the composition and nature of the oxide film. The existence of large amounts of Cr_2O_3 in the film reduces the tendency for carburization in the higher chromium content alloys. (auth)

26773 STATIC CORROSION OF NIOBIUM BY MOLTEN URANIUM–CHROMIUM EUTECTIC. Delwyn D. Bluhm and Ray W. Fisher (Ames Lab., Ames, Iowa). J. Nucl. Mater., 16: 42-8(May 1965). (IS-599)

The results of corrosion rate tests with molten U–Cr eutectic (95 wt % U–5 wt % Cr) contained in solid niobium under static conditions are presented. The eutectic was capsulated in 30 mil (0.76 mm) niobium crucibles and these in turn were sealed in Inconel containers for protection from oxidation. Corrosion measurements were made after the crucibles were tested for varying lengths of time at temperatures of 900, 950, and 1000°C. Photomicrographs of the diffusion band at the interface between the solid metal and the liquid metal were used to determine the corrosion mechanism. The rates of corrosion at the three test temperatures were determined by measuring the reduction in wall thickness. The rate of corrosion was found to be temperature and time dependent. The initial rates of corrosion were found to be high and to increase with increased temperature. The rapid decrease of the corrosion rates with time was attributed primarily to the corrosion mechanism. It was concluded that under static conditions molten uranium-chromium eutectic can be contained in niobium for short-term applications. (auth)

26774 REACTION OF FLOWING STEAM WITH REFRACTORY METALS. I. MOLYBDENUM (1100-1700°). Martin Kilpatrick and Stanley K. Lott (Argonne National Lab., Ill.). J. Phys. Chem., 69: 1638-40(May 1965).

When flowing steam reacts with molybdenum metal in the temperature range 1100 to 1700°C, the products of reaction were hydrogen gas and a vapor of $(MoO_3)_n$ and $MoO_2(OH)_2$. The molybdenum metal showed a thin film of lower oxide. The over-all rate for constant pressure of steam was constant with time and was understandable in terms of a steady state. (auth)

26775 OXIDATION OF MOLYBDENUM SILICIDES AT HIGH TEMPERATURES AND LOW PRESSURES. R. W. Bartlett and P. R. Gage (Philco Corp., Newport Beach, Calif.). Trans. Met. Soc. AIME, 233: 968-74(May 1965).

At high temperatures and reduced oxygen pressures, molybdenum silicides oxidized to form SiO(g) rather than a passivating SiO_2 film. As oxidation proceeded, the higher oxidation potential of silicon initially suppressed oxidation of molybdenum and silicon was depleted near the surface. Eventually, silicon depletion caused secondary passivation (SiO_2) and an active to passive transition in oxidation behavior at moderately low pressures. At very low pressures, silicon depletion continued until steady-state oxidation of both silicon and molybdenum could proceed at rates proportional to their initial stoichiometries. Observations of oxidation-rate behavior at temperatures from 1100 to 1700°C and oxygen pressures from 10^{-7} to 1 atm were made using thermogravimetric, x-ray diffraction, and electron-microprobe techniques. The experimental results were in good agreement with calculated limits for the various types of behavior based on thermochemical and diffusion rate data for the Mo–Si system. (auth)

26776 THE ZIRCONIUM–HAFNIUM–HYDROGEN SYSTEM AT PRESSURES LESS THAN 1 ATM. PART I. A THERMOCHEMICAL STUDY. O. M. Katz (Westinghouse Electric Corp., West Mifflin, Penna.) and J. Alfred Berger. Trans. Met. Soc. AIME, 233: 1005-13(May 1965). (WAPD-T-1738)

The Zr–Hf–H ternary system was studied between 500 and 900°C at pressures less than 1 atm of hydrogen gas between 1 and 60 at.% H. The microgravimetric apparatus used is described. Changes of slope on pressure-hydrogen composition isotherms delineated phase boundaries. These boundaries separated the three regions, α, β, and γ so designated to correspond to the regions of the Zr–H binary system, from the multiphased areas between them. A eutectoidal decomposition was found with the β region phase or phases decomposing into a lamellar product on quenching to room temperature. Reproducible decomposition-pressure hysteresis occurred mainly at lower hydrogen compositions and at lower temperatures across multiphase regions between α and β and α and γ. The effects of hafnium on the hydriding characteristics of zirconium were as follows: stabilization of the α and γ regions while destabilizing the β region; appreciable elevation of the decomposition pressures in the multiphase region between the α and β field; movement of the eutectoid reaction to high temperatures; reduction in the total quantity of hydrogen absorbed under one atmosphere of H_2 pressure; and introduction of a split decomposition at the eutectoidal point in part of the ternary. Assumptions based on an interstitial random-solution model of hydrogen in metals showed that the binding energy between solute sites predominated at low hydrogen concentrations. However, at high hydrogen contents the entropy was the predominant factor in determining the stability of the Zr–Hf–H alloys. This was interpreted to mean a scarcity of further interstitial solute sites caused by hydrogen-hydrogen interactions in the metal lattice. (auth)

26777 THE ZIRCONIUM–HAFNIUM–HYDROGEN SYSTEM AT PRESSURES LESS THAN 1 ATM. PART II. A STRUCTURAL INVESTIGATION. O. M. Katz (Univ. of Pittsburgh, Penna.) and J. Alfred Berger. Trans. Met. Soc. AIME, 233: 1014-22(May 1965). (WAPD-T-1740)

Selected samples of hydrided Zr–Hf alloys were rapidly quenched to room temperature and examined metallographically, by x-ray diffraction, and through microhardness studies to confirm high-temperature data. Confirming experiments showed that there were five phases in this ternary system: hexagonal with lattice parameters similar to that of the initial Zr–Hf alloy but slightly enlarged due to dissolved hydrogen; fcc with properties of a brittle, intermediate, hydride compound; fct with c/a around 1.07 and which appeared as a needlelike precipitate; hexagonal, designated θ, with c/a ratio of 2.37; and orthorhombic, designated λ, with a = 4.67, b = 4.49, and c = 5.09Å and whose microstructural appearance depended on heat treatment. The tetragonal phase never appeared without the cubic hydride. Appearance of θ and λ also depended on the hafnium content of the zirconium. (auth)

26778 CORROSION OF STAINLESS STEELS BY ZINC VAPOR. G. A. Bennett, P. A. Nelson, and L. Burris, Jr. (Argonne National Lab., Ill.). Trans. Met. Soc. AIME, 233: 1032-6(May 1965).

Stainless steels were much less severely attacked by zinc vapor than by molten zinc systems. To determine the applicability of stainless steels for equipment items, which would be exposed only to zinc vapor, the corrosion resistance of several stainless steels to zinc vapor was investigated in 500-hr exposures at 900°C. Two austenitic

stainless steels, Types 304 and 347, suffered severe intergranular attack. Loss of nickel from these steels and microprobe analyses indicated the probable formation of low-melting zinc-rich phases. Good resistance to attack by zinc vapor, as determined by metallographic examination and physical testing, was exhibited by Type 405 stainless steel, a ferritic steel. Type 440C stainless steel, a martensitic steel, although suffering considerable loss in weight, was not structurally weakened. (auth)

Fabrication

Refer also to abstracts 26600, 27781, 27794, and 27806.

26779 (AD-611162) FABRICATION OF WIDE TUNGSTEN SHEET BY POINT DEFORMATION TECHNIQUES. Final Report. Samuel A. Worcester (Wah Chang Corp., Albany, Oreg.). Dec. 31, 1964. Contract NOw 61-1046-c. 165p. $5.00(CFSTI).

An experimental program was conducted to establish the feasibility of producing high quality wide tungsten sheet through use of the flow turning process. To establish basic limitations for the flow turning of various tungsten starting materials, a series of 90-degree included angle cones were flow turned from 0.125 in. thick tungsten plate. It was established that as-sintered, sintered and forged, sintered and rolled, and arc cast and rolled plates could be flow turned at minimum temperatures of 1400, 1100, 900, and 600°F, respectively. (auth)

26780 (AECL-2209) EXPLOSIVE BONDING OF DISSIMILAR METAL TUBES. A. W. L. Segel (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1965. 102p. Dep.; $2.00(AECL)

Techniques for bonding concentric tubes of dissimilar metals by the controlled detonation of high explosives were partially investigated through efforts to develop two applications. One examined the lining of the inner surface of stainless steel or Zircaloy tubing with a thin sheath of aluminum in a process of sheathing pressure tubes to reduce hydriding. The other was concerned with the joining of Zircaloy to stainless steel tubing. Two different bonding mechanisms appeared to be operative with aluminum. At low pressures (4×10^4 to 1×10^5 lbf/in.^{2}) strong bonds were produced which were relatively free of brittle intermetallics provided the base metal was pre-oxidized, there was a good vacuum between the metals, and the aluminum was elongated enough to break up its own oxide film. None of the low-pressure experiments resulted in bonding over the entire tubular interface. In the high-pressure range (1×10^5 to 3×10^6 lbf/in.^{2}) there was bonding over the entire tubular interface, but the tube size could not be maintained. Near the tube ends the bonds were strong and the interface between the metals was wavy (a characteristic of surface jetting) with discontinuous pockets of intermetallics. Most of the balance of the tube displayed a straight interface with a relatively diffusionless but weak bond. Zircaloy could only be bonded to stainless steel at high pressures. The interface was wavy and had large pockets of intermetallics. Where these became continuous, the bond failed. (auth)

26781 (AECL-2241) DIFFUSIONLESS BONDING OF ALUMINUM TO TYPE-304 STAINLESS STEEL. R. D. Watson (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1963. 19p. Dep.; $1.00(AECL)

High-strength diffusionless bonds were produced between 1S aluminum and oxidized 304 stainless steel by hot pressing and extrusion bonding. Both the hot pressing and extrusion bonding techniques were developed to a point where consistently good bonds could be obtained. Although the bonding is performed at elevated temperatures (about 510°C) a protective atmosphere is not required to produce strong bonds. The aluminum-stainless steel bonded specimens can be used to join aluminum and stainless steel by conventional welding. Welding close to the bond zone did not appear to affect the integrity of the bond. (auth)

26782 (AECL-2243) DIFFUSIONLESS BONDING OF ALUMINUM TO ZIRCALOY-2. R. D. Watson (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1965. 17p. Dep.; $0.50(AECL)

Aluminum can be bonded to zirconium without difficulty even when a thin layer of oxide is present on the surface of the zirconium. No detectable diffusion takes place during the bonding process. The bond layer can be stretched as much as 8% without affecting the bond. The bond can be heated for 1000 hours at 260°C (500°F), and can be water quenched from 260°C (500°F) without any noticeable change in the bond strength. An extrusion technique was devised for making transition sections of aluminum bonded to zirconium, which can then be used to join these metals by conventional welding. Welding can be done close to the bond zone without seriously affecting the integrity of the bond. (auth)

26783 (AECL-2244) EFFECT OF THE ALUMINUM FLOW PATTERN ON THE BONDING OF ALUMINUM TO OXIDIZED ZIRCALOY-2. R. D. Watson and J. P. Lambert (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan. 1964. 11p. Dep.; $0.50(AECL)

The bonds produced when hot aluminum is allowed to flow smoothly from an extrusion die to the oxidized surface of a heated tube of Zircaloy-2 were consistently inferior to those produced with back-extruded flow. The difference was believed to be due to the reduction in, or elimination of, the oxide layer on the aluminum that comes in contact with the surface of the Zircaloy-2. (auth)

26784 (CEA-R-2737) FABRICATION DE PASTILLES D'OXYDES MIXTES D'URANIUM ET DE PLUTONIUM. (Fabrication of Mixed Uranium and Plutonium Oxide Pellets). Guy Dean, Camille Pelou, and Desire Beugnies (Commissariat â l'Énergie Atomique, Fontenay-aux-Roses (France). Centre de Études Nucléaires). Jan. 1965. 40p. Dep.(mn).

Results of sintering of UO_2– PuO_2 solid solutions are presented. Two processes are described: the first one is the standard process involving mechanically mixed oxides PuO_2 and sinterable UO_2, whereas in the second one, direct mixtures of UO_3 or U_3O_8 and PuO_2 are pressed and sintered. For the two processes, sintering is carried out in flowing pure or dilute hydrogen at a temperature of 1650°C during four hours. In both cases, the $(U,Pu)O_2$ pellets have the same general characteristics ($PuO_2 \approx 20$ per cent):. a bulk density between 96 and 99 per cent of the theoretical density, a single phase product with grains of about 10 to 20 μ, and an oxygen-to-metal ratio varying between 2.00 and 1.95 according to the moisture content of the sintering atmosphere. (auth)

26785 (INR-557/XIV) SWAGING METALLIC AND NONMETALLIC POWDERS IN METALLIC TUBES. W. Rutkowski, W. Szteke, and M. Wieczorkowski (Institute of Nuclear Research, Warsaw (Poland)). Nov. 1964. 44p. Dep.

Experiments on densification by swaging metallic powders of Cu, Mg, Al, nonmetallic powders of Al_2O_3, UO_{2+} , and their dispersions, canned in aluminum, SAP, and steel tubes were performed. Density, hardness, macrostructure, and the distribution of core material at rod ends were investigated. At higher reduction grades, appropriate results for density could be achieved. (auth)

26786 (LA-DC-6821) EPOXY RESIN BONDED MACHINABLE CERAMICS. Robert E. Cowan and E. P. Ehart (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 18p. (CONF-650513-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Ceramic Society, Annual Meeting, Philadelphia.

The technique of epoxy resin-bonding ceramic materials was developed in order to provide a material that had good green strength for machining operations. Pure alumina was used, but other materials, such as iodides, zirconates, and titanates may also be used. Formulation of the resin system is described. Toxic effects in working with epoxy resins and economics of the method are discussed. (P.C.H.)

26787 (RMI-2) AN EVALUATION OF DYNAPAK (HERF), EXTRUDED URANIUM TUBES. Q. C. Carloni and L. Robins (Reactive Metals, Inc., Ashtabula, Ohio).

Apr. 9, 1965. Contract AT(30-1)-1405. 78p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Two experiments, UB-32 and UB-35, were performed to investigate the Dynapak machine (Model 1800 Horizontal) as a production tool for the fabrication of I&E 'O' size uranium fuel element tubing. Thirty-eight billets were extruded over a period of four days during UB-32 for dimensional, structural, and quality evaluations of the extruded products. In addition, OD machining and tooling evaluations were performed. Five billets were extruded during UB-35 due to the tube warpage encountered during UB-32. Thermal expansion coefficients and x-ray diffraction data were obtained from one of the extruded tubes and two tubes were beta heat treated to gather information as to the cause of the warpage problem. The data indicated that the warpage was caused by a bimetallic strip action due to circumferential variations in grain orientation. Methods to eliminate the warpage are presented. A statistical dimensional analysis of the extruded tubes showed the following results: (a) the mean extruded tube length ($\bar{x}$) decreased during the period of the thirty-eight (38) extrusions (this was attributed to die wear); (b) the mean depth of rear end defect increased as the mean tube length decreased; (c) the good metal yield is affected by the tube length and depth of rear end defect; (d) the degree of tube warpage increased steadily from the first to fourth day; (e) close ID tolerance control was exhibited; (f) a decrease in tube eccentricity was observed as the extrusion campaign progressed. An OD machining test on the extruded tubes revealed high quality surfaces. Die wear for 43 firings (0.025 in.) was excessive and influenced the OD, W.T., and length measurements. Macrostructural evaluations revealed a fine grained alpha structure at the front of the extruded tube, a coarse grained alpha structure in the center of the extruded tube (occasionally a columnar structure is evident on the tube O.D.), and a fine grained alpha structure in the rear of the extruded tube. These observations suggest that the billet temperature be decreased to eliminate the coarse grained mid-length region and thus obtain a more uniform fine grained alpha structure. Beta heat treatments of the extruded tubes reveal that thermal gradients exist in the extruded tube causing it to act as a bi-metallic strip. Thermal expansion coefficient and x-ray data revealed circumferential variations in thermal expansion behavior and grain orientation. (auth)

26788 CONDENSATION OF TUNGSTEN ON TUNGSTEN IN ATOMIC DETAIL: OBSERVATION WITH THE FIELD-ION MICROSCOPE. Theodore Gurney, Jr. (Yale Univ., New Haven). Franklin Hutchinson, and Russell D. Young. J. Chem. Phys., 42: 3939-42(June 1, 1965).

Tungsten was condensed onto a clean tungsten point in a field-ion microscope held at liquid-nitrogen and liquid-hydrogen temperatures. Stepwise field evaporation was employed to observe the structure of the deposit in atomic detail. The first layer of deposited tungsten atoms above the substrate appeared to contain one-fourth to one-third vacancies. The possibility of extending the range of specimens observable in the field-ion microscope by employing a shadowing technique, which would leave a highly detailed imprint of the specimen on the emitter surface, is discussed. It was concluded that the imperfect first layer of deposited tungsten observed in these studies would reduce the fidelity with which the details of the specimen could be observed for high-resolution microscopy. (auth)

26789 CONDENSATION OF TUNGSTEN ON TUNGSTEN IN ATOMIC DETAIL: MONTE CARLO AND STATISTICAL CALCULATIONS VS EXPERIMENT. Russell D. Young and David C. Schubert (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 42: 3943-50(June 1, 1965).

The arrangement of tungsten atoms evaporated onto a low-temperature tungsten substrate was previously reported. Results of Monte Carlo and statistical calculations assuming that the condensing atoms either remain in the first potential well they encounter on contacting the surface (migration-free condensation) or make one or more surface migration "jumps" before being permanently bound are discussed. A comparison of the two calculations with experimental results led to the conclusion that, at least below 77°K, tungsten atoms remain in the first potential well they encounter. It is shown that migration-free condensation is predicted by a one-dimensional calculation. (auth)

26790 A CONTRIBUTION TO THE HISTORY OF DUCTILE TITANIUM AND ZIRCONIUM. W. J. Kroll. J. Less-Common Metals, 8: 361-7(June 1965).

Development of the present-day production method for titanium by reduction from its chloride under noble gas is reviewed. The various steps taken are shown in chronological order and sketches taken from laboratory journals present the evolution of the reduction equipment. The development work accomplished later in zirconium reduction based on the method used for titanium is reported. (auth)

26791 PREPARATION AND MAGNETISATION OF SUPERCONDUCTING NIOBIUM–TIN CYLINDERS. G. W. Coles, J. M. Corsan, A. Buxton, and B. Lewis (General Electric Co. Ltd., Wembley, Eng.). J. Less-Common Metals, 8: 402-18(June 1965).

Alloys were prepared by pressing compacts of the powdered elements in stoichiometric proportions corresponding to the phase Nb_3Sn and sintering at various temperatures. Phase studies were made using x-ray diffraction, metallography, and micro-hardness techniques. The results were correlated with sintering treatment and superconductive properties. The superconductive properties were studied by observing the magnetization of specimens in cylindrical form at 4.2°K in fields of up to 54 koersted. Cylinders with wall thicknesses of less than 4 mm were found capable of trapping fields of up to about 50 koersted corresponding to an average critical current density of about 0.75×10^5 amp cm^{-2}. (auth)

26792 DENSE CALCIUM FLUORIDE VESSELS FOR URANIUM SMELTING. P. Rado (Worcester Royal Porcelain Co. Ltd., Worcester, Eng.). J. Metals, 17: 494-9 (May 1965).

The manufacture of dense calcium fluoride vessels; their general properties; and their use in the production of enriched uranium are described. (auth)

26793 AN INVESTIGATION INTO METHODS FOR THE PARTICLE-SIZE ANALYSIS OF UO_2 POWDER AND THE EFFECT OF BALL-MILLING ON SIZE DISTRIBUTION. C. C. Bazell and R. V. Davies (Atomic Energy Establishment, Winfrith, Dorset, Eng.). Powder Met., 8: No. 15, 38-63(1965).

Techniques for particle-size analysis of ceramic-grade UO_2 in the 4 to 40 μm size range were assessed, with a view to selecting the most suitable method for analysis of UO_2/PuO_2 mixtures under glove-box conditions. The β-backscatter method was considered to show some advantages over the Coulter counter or optical microscopy methods, and the mean coefficient of variation was ±1.2% at the 1σ level. The effects of various forms of pretreatment, e.g., high-speed stirring, manual mixing, and ultrasonic shaking, were examined. These are discussed in relation to the agglomerative properties of UO_2. Ultrasonic shaking was the most successful form of dispersion and the necessity of standardizing the pretreatment stage is emphasized. Beta backscatter was used to compare particle-size distribution after wet and dry ball-milling. While little difference was observed in the ultimate particle-size produced by the two treatments, the effect of agglomeration in dry milling was clearly shown. The increased effectiveness of milling UO_2 powder in a suitable dispersing medium rather than water, was demonstrated. (auth)

26794 SINTERING OF ZIRCONIUM BORIDE WITH ACTIVATING ADDITIONS. B. Cech, P. Oliverius, and J. Sejbal (Powder Metallurgy Inst., Sumperk, Czechoslovakia). Powder Met., 8: No. 15, 142-51(1965).

Since the hot pressing of ZrB_2 compacts has a number of limitations, the possibility of pressureless sintering by the addition of small amounts of various metals to provide a liquid phase was investigated. Changes in microstructure and porosity of the compacts were studied. Additions of up to 3% of iron, nickel, cobalt, or high-melting-point metals enabled satisfactory sintering at 2000°C in argon or in

vacuum to be achieved in <60 min. The effect was associated with an appreciable contraction of the ZrB_2 lattice. (auth)

26795 METHOD OF PRODUCTION AND SOME PROPERTIES OF A NEW TYPE OF ULTRAFINE PARTICLES. L. L. Szego (Houghton-Szego Labs., Ltd., London) and D. H. Houseman. Powder Met., 8: No. 15, 162-75 (1965).

A micro-rolling method for the production of fine metallic particles in the size range from 0.05 to 5 μm is described, together with equipment for separation and collection of predetermined size fractions. The material produced is a flake form of high (up to 100:1) breadth:thickness ratio and is suitable for applications such as dispersion-hardening and for many operations that involve pressing and sintering procedures. Details are given of particle shape and size distribution for two typical products, aluminum flake and tungsten flake. Some physical properties of specimens produced from these materials are also cited. Reference is made to other products of the mill, both metallic and non-metallic, and to future development work in relation to these materials. (auth)

26796 STUDIES ON THE WELDING OF HIGH TENSILE STRENGTH STEEL PLATES FOR REACTORS. PART III. Yosetsu Gijutsu, 12: No. 6, 62-7(June 1964). (In Japanese)

The processes used in trial production of materials for welding thick steel plates are reported. Studies were made on the submerged arc welding of high-tensile-strength steels, i.e., the HT60 (T.S.: 60 kg/mm²) series such as 6ND, 6NG, 6NF, and 6NE, and the HT70(T.S.: 70 kg/mm²) series such as 7QD and 7QC. After several tests on the heats of steel, low-alloy steels to give a deposited metal composed of Ni-Cr-Mo steel were selected as the filler materials. Fluxes were also selected after the combined tests with the filler metals. Welded metal samples prepared using the materials were tested for yield point, tensile strength, and elongation, and on bending and impact characteristics. Investigations conducted on the welding materials for the electroslag process are also reported. (NSA of Japan)

26797 STUDIES ON THE WELDING OF HIGH TENSILE STRENGTH STEEL PLATES FOR REACTORS. PART IV. Yosetsu Gijutsu, 12: No. 7, 54-60(July 1964). (In Japanese)

In the first part of the report, the processes of production of the welding materials for thick steel plates are described. Materials for the carbon dioxide gas arc welding and the union arc welding of HT60 and HT70 were selected after several tests. The second part deals with the weldability of plates 100 mm thick. Studies were made by the restraint crack tests on Y- and U-type groove welds made from the covered electrodes and on welds made by automatic welding. The results obtained are summarized as follows: (1) For the steels tested (T.S. 60 kg/mm² and 70 kg/mm²), root cracks in the restraint welds on the Y-groove may be prevented by preheating the base to about 200°C or higher, the temperature of preheating depending on the base steels used; (2) all the root cracks in the restraint welds on the U-groove may be prevented by preheating the base steel to about 150°C; (3) in the automatic welding processes, the lowest sensibility of root crack is obtained for welds made by the CO_2-O_2 process. (NSA of Japan)

26798 TEST AND STUDY ON THE WELDING OF BORON STEELS FOR USE IN A NUCLEAR REACTOR. [PART] 3. Yosetsu Gakkaishi, 13: No. 2, 73-81(Feb. 1965). (In Japanese)

Studies of the welding of boron steels are reported. Mechanical and corrosion properties of boron austenitic steels are described. In the 1.6 and 2% boron austenitic steels, the effect of aging on properties was hardly observable, and their composition was very stable. Welding did not cause brittleness, but corrosion resistance in the heated weld was lower. Tests were conducted to establish welding standards for both the boron austenitic and ferrite steels. As the welding filler, a submerged-arc filler was found to be the best. The welds of boron ferrite steels were subject to cracking; but in boron austenitic steels, welds were possible, provided suitable welding conditions were used. For 2% boron austenitic steel, the results of tests are described for inert-gas shielded and tungsten-arc welding methods. Welding of boron austenitic steel to boron ferrite steel is also described. (NSA of Japan)

26799 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF CARBON. Hugh Wilson Davidson (to General Electric Co. Ltd.). British Patent 889,351. Feb. 14, 1962. Filed Nov. 21, 1958.

A process for producing a carbon article consists of forming a dispersion in water of hemicellulosic material, removing the material from the suspension, shaping and drying the material, heating it to form carbon, and subjecting the carbon to a graphitization process at a temperature higher than 2100°C. Carbon so produced has substantially zero permeability and is stable in non-active atmospheres up to graphitizing temperatures. (A.G.W.)

26800 IMPROVED PROCESS FOR THE MANUFACTURE OF CAST PRODUCTS BY METAL POURING AND DEVICE FOR THE CARRYING INTO EFFECT THEREOF. Yves Baudet and Hubert Fournial (to Societe Industrielle de Combustible Nucleaire). British Patent 985,169. Mar. 3, 1965. Priority date Jan. 30, 1963, France.

The apparatus described for casting metal by gravity pouring eliminates the cake of excess solid metal usually left in the lower portion of the distributor after the molds are filled. The molten metal flows from the melting crucible through a distributor located under the crucible into molds permanently connected with the distributor. After the molds are completely filled, an orifice in the distributor is fractured, which permits the excess metal to flow into an auxiliary container. The metal is allowed to solidify and the cast products are withdrawn from the molds. The process is specifically described with reference to casting of uranium bars. (A.G.W.)

Properties and Structure

Refer also to abstracts 26893, 27381, 27709, and 27789.

26801 (AD-607530) COATED REFRACTORY METAL EMITTANCE SPECIMENS. H. W. Leavenworth, Jr., E. A. Schatz, M. E. Browning, and F. J. Dunkerley (American Machine and Foundry Co., Alexandria, Va.). Feb. 1964. Contract AF33(657)-11330. 78p. (ML-TDR-64-148). $3.00(CFSTI).

Four niobium-base alloys were coated with oxidation resistance coatings by four different industrial organizations and submitted for measurement of thermal radiation and other general physical properties at 1520°F. Basic acceptance data obtained for these four coated-niobium base alloys included photomicrographs of the coatings before and after a six-hour stability test, physical observation of the stability of the coatings at 2500°F at hourly intervals to a maximum of six hours, surface roughness measurements, and such thermal optical data as total normal emittance, spectral emittance, and spectral reflectance. Companion specimens of the four niobium alloys coated by the four different organizations were submitted to the Materials Applications Divison of RTD for their in-house thermal radiation physical property studies. (auth)

26802 (AD-610564) MECHANICAL AND PHYSICAL PROPERTIES OF TZM MOLYBDENUM ALLOY SHEET AND OF TUNGSTEN SHEET. Quarterly Progress Report No. 8, September 1–December 1, 1964. (Southern Research Inst., Birmingham, Ala.). Jan. 22, 1965. Contract N600(19)59530. 50p. (SRIB-7144-1479-VIII). $2.00 (CFSTI).

All room-temperature unnotched-tensile measurements in the longitudinal and transverse directions were completed on the 0.016-, 0.020-, 0.040-, and 0.060-in. TZM sheet in the optimum and recrystallized conditions. A statistical procedure suitable for an analysis of the

variance of the tensile data for the TZM sheet was set up and programmed in a computer. The results of the statistical analysis of the variations of the between thickness, between heat, between sheet, and within sheet room-temperature tensile properties measured during this and previous report periods are discussed. (W.L.G.)

26803 (AD-611165) CRYOGENIC MATERIALS DATA HANDBOOK. Progress Report No. 1. F. R. Schwartzberg, S. H. Osgood, R. D. Keys, and T. F. Kiefer (Martin Co., Denver, Colo.). Feb. 1965. Contract AF33(756)-9161. 260p. (ML-TDR-64-280(Suppl.); PB-171809(Rev.)(Suppl.1)). $6.00(CFSTI).

The completely revised 'Cryogenic Materials Data Handbook' presently contains mechanical and physical property data on 62 metallic and nonmetallic materials organized in eight sections. The Handbook also contains material, property, and accumulative indices and reference list. (auth)

26804 (AD-613350) ANISOTROPY AND STRENGTH OF CERAMIC BODIES. Progress Report No. 9-12, October 15, 1963–October 15, 1964. W. R. Buessem, H. A. McKinstry, and G. R. Barsch (Pennsylvania State Univ., University Park). Oct. 15, 1964. Contract Nonr-656(27). 61p. $3.00(CFSTI).

Discussions are presented on the correlation between the thermal expansion anisotropy and the strength of ceramic bodies, the relation between the elastic constants of single crystals and those of polycrystals, the theory of mechanical strength for brittle fracture of ceramic bodies, and the anisotropy of elastic constants. A compilation of elastic constants for cubic materials and data for the velocities of ultrasonic waves in fused silica at high temperatures and the thermal expansion anisotropy of aluminum titanate are presented. (W.L.G.)

26805 (AECL-2207) THE EFFECT OF SPECIMEN GEOMETRY ON THE TENSILE PROPERTIES OF SOME ZIRCONIUM ALLOYS. C. C. Sanderson (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1965. 29p. Dep.; $1.00(AECL)

The effects of specimen geometry on the tensile properties of Zircaloy-2, Zr-2.5 wt. % Nb, and Zr-2.5 wt. % Nb-0.5 wt. % Cu in a variety of metallurgical conditions were investigated using two types of tensile specimen. With flat tensile specimens, little effect on tensile properties was observed for specimen width-to-thickness ratios ranging from 2 to 8 in room temperature and 300°C tests. In the ring tensile tests, however, where the width-to-thickness ratio was varied from 2 to 18, variations in ultimate tensile stress and total elongation and reduction of area were observed. It was concluded that specimen geometry is of little importance for flat tensile specimens. In ring specimens, however, the tensile properties are dependent on width-to-thickness ratio and it is recommended that the ratio should be such that a minimum amount of longitudinal restraint is imposed on the specimen by the grips. (auth)

26806 (AEET/CD/23) PREPARATION AND STRUCTURAL CHARACTERISTICS OF δ-U_3O_8— A HIGH TEMPERATURE MODIFICATION. M. D. Karkhanavala, A. M. George, and V. Amirthalingam (Atomic Energy Establishment, Trombay (India). Chemistry Div.). 1964. 13p. Dep.(mn).

By heating α-U_3O_8 to high temperatures (T > 1100°C) and cooling extremely slowly, a different modification of U_3O_8 is obtained. This was first reported by Notz et al. However, they considered it to be β-U_3O_8 reported earlier by Hoekstra and Siegel. The present study has shown that these two modifications are different and the U_3O_8 obtained by the method of Notz et al is now designated δ-U_3O_8. The yield of δ-U_3O_8 is found to be highly dependent on the soaking temperature, the optimum being 1350°C. δ-U_3O_8 were studied by differential thermal analysis and x-ray diffraction methods. The x-ray investigations on powders gave an orthorhombic cell of a = 6.70 Å, b = 12.46 Å, and c = 8.53 Å. Single crystal data show a smaller cell: a = 6.70 Å, b = 4.14 Å ($\sim\frac{1}{3}$ b powder) and c = 8.53 Å; space group $C_{cc}2$ and Z = 4 $UO_{2.67}$. (auth)

26807 (AEET/MET/4) DIMENSIONAL INSTABILITY IN CADMIUM DURING THERMAL CYCLING. M. L. Mehta and K. Tangri (Atomic Energy Establishment, Trombay (India). Metallurgy Div.). 1964. 18p. Dep.(mn).

The effects of grain size, the type of texture present, and the cycling temperature range on the growth of Cd during thermal cycling were investigated. The growth behavior of Cd was found to be similar to that reported in other thermally anisotropic metals. However, the magnitude of growth, as compared to that observed in U, Zn, and Zr, is far less than would be expected from theoretical consideration based on thermal anisotropy and yield strength of the metals considered. It was experimentally shown that low magnitude of growth in Cd is not due to its low recovery temperature or the grain coarsening which was observed during cycling. It is suggested that Cd is not provided with the type of texture necessary for producing optimum growth. (auth)

26808 (AHSB(S)R-81)) THE SIGNIFICANCE OF RECENT DEVELOPMENTS IN FRACTURE MECHANICS IN GREAT BRITAIN IN RELATION TO THE SAFETY OF REACTOR PRESSURE VESSELS. W. H. Irvine (Authority Health and Safety Branch, United Kingdom Atomic Energy Authority, Risley (England)). 1965. 13p. (CONF-512-18)

From American Society for Testing and Materials 67th Annual Meeting, Chicago, June 1964.

Theoretical and experimental evidence has in the past suggested that fast fracture in plated structures is controlled by structural behavior and material properties. Recent work in the U.K.A.E.A. involving tests to failure on 5-ft diameter, 14-ft long, cylindrical steel pressure vessels containing 6 in. to 24 in. long slits, confirms that for constant load conditions such as exist in a pneumatic test, crack arrest does not occur, while under conditions which are nearer to the constant strain case, such as exist in a hydraulic test, the extent of crack propagation is controlled by fracture toughness and total energy available. In addition this work indicates that a correlation of the form $f\ell^3]^2$ = function of (φ, f_y, f_u) exists between the critical parameters, crack length l, gross stress f_g, Charpy energy absorption φ, yield stress f_y, and ultimate tensile stress f_u. When considered in conjunction with the relationship between the main parameters and plastic zone size, this correlation suggests that in addition the critical condition is affected by the path along which instability is approached; for instance, by increase in crack size, increase in stress or change in material properties. Since energy availability controls fracture appearance through plastic zone size, strain rate, and crack speed, cleavage and shear fracture may exist side by side at the same temperature and it is suggested that the interpretation of service and test failures of steel structures should be based on an analysis of factors such as load history, stress level, flaw size, and Charpy value, rather than on a fracture appearance temperature approach. The safety implications of these effects in relation to proof testing, annealing out of irradiation damage, and material monitoring are discussed. (auth)

26809 (ASD-TDR-62-509(Vol.VI)) BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. INFLUENCE OF THE DISTRIBUTION OF OXIDE AND OF THE TOTAL IMPURITY LEVEL ON RECRYSTALLIZATION AND GRAIN GROWTH OF BERYLLIUM. J. Moriceau, J. M. Logerot, M. Croutzeilles, A. Saulnier, R. Syre, and P. Vachet (Compagnie Pechiney, Chambery (France)). Jan. 1964. Contract AF33(616)-7065. 96p. (AD-613952). $3.00(CFSTI).

The starting material was either Pechiney SR beryllium or Brush QMV beryllium. Sheets were fabricated by forging and hot rolling, within cans, of cast billets or billets compacted from powder, and the sheets were then warm rolled. The temperatures of recrystallization decreased with the amount of reduction and varied from 700–730°C on the average for SR cast metal, to 760–765°C for Brush cast metal, to 800–810°C for the powder metallurgy materials. Examinations by optical and electron microscopy were carried out on all the materials and on the worked sheets after heat treatments in the recovery, recrystalliza-

tion, and at grain growth temperatures. In the as-cast condition, Brush beryllium can be distinguished from SR by a finer grain size and numerous inclusions. Forging and hot rolling leads to a strong deformation of the grains. In this condition, the SR metal is recrystallized while Brush metal remains worked. Warm rolling decreases this difference. The worked state is characterized by some grains which are slightly deformed, surrounded by a mass of highly distorted material, particularly in the case of Brush metal. The slightly deformed grains consist of slightly disoriented sub-grains containing a small number of dislocations. Between these grains is a confused region in which deformed blocks can be distinguished in the middle of dense veins of dislocations. The recrystallization of such a structure results from the competition of two processes: on the one hand, the reorganizations in situ of the lightly deformed grains by the elimination of dislocations and the coalescence of subgrains; on the other hand, the appearance of nuclei at the expense of these large grains. This latter process appears preponderantly in the Brush metal. At equal levels of deformation, grain size is finer for Brush metal than for SR. Recovery leads to a more or less complete rearrangement of the substructure. At high temperature, grain growth occurs, the rate of growth being greater the purer the metal. In the metal of powder origin, the continuous oxide film which surrounds each grain of powder is entirely destroyed by forging and hot rolling, and is broken into particles of $1/100$ to several tenths of a micron dispersed in layers parallel to the surface of the sheet. These particles are smaller and more numerous for the –200 mesh powders. These oxide layers no longer constitute insurmountable obstacles for the grain boundaries as shown by the fact that the powdered and rolled Brush metal exhibits an abnormal grain size comparable to that of cast metal. The SR powder materials, by contrast, preserve a fine grain size throughout the fabrication operations. These structural differences are found again after warm rolling. During recrystallization, powdered Brush metal changes in the same manner as cast metal. During recrystallization of the powdered SR materials, nuclei appear which grow rapidly to approximately a 20-micron size. In both cases, prolonged heating at high temperature causes only a slight grain growth. Mechanical properties during tension and bending were measured on the entire collection of fabricated products and annealed sheets. In the forged state, the powder metals have better mechanical properties than the cast metal, which is fragile. Hot rolling improves the properties of cast metal but lowers slightly those of powdered SR and causes powdered Brush metal to become very fragile because of abnormal grain growth. After working, the best combinations of mechanical properties are obtained in the recrystallized conditions. Recovery treatments have given good results only for Brush cast metal. With regard to grain growth treatments, these seem to improve the bendability of cast metal, but in all cases are catastrophic for the tensile properties. For the SR metal, the mechanical properties improve as the grain size becomes smaller. Such a correlation has not been found for Brush metal of this type. It is concluded that: (a) Increase of the impurity content in beryllium raises the recrystallization temperature and decreases the tendency for grain growth by restraining the movement of grain boundaries. (b) At high levels of deformation, the distribution of oxide does not seem to be fundamentally different for the material originating from the different types of powder. (c) The layers of oxide effectively restrain the motion of grain boundaries to the point of making grain growth negligible but do not always constitute an insurmountable barrier for these boundaries. (d) In all cases, the conditions of fabrication play a fundamental role in the subsequent behavior of the metal, especially with respect to the mechanical properties. (auth)

26810 (BMI-X-10118) FISSION-PRODUCT REACTIONS WITH AND RELEASE FROM FUEL-ELEMENT CLADDINGS. Quarterly Progress Report, January–March 1965. Duane N. Sunderman, David L. Morrison, James E. Howes, Jr., and Edward J. Jablonowski (Battelle Memorial Inst., Columbus, Ohio). Apr. 1, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 7p. (EURAEC-1364). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Progress is reported in the measurement of the diffusion coefficients of nongaseous fission products in fuel element cladding materials. Diffusion coefficients were measured for Zr and Te in Zr at 650 and 750°C. A uniform distribution of Ru in Zr was obtained over the diffusion range studied. (W.L.G.)

26811 (BNWL-13) PHYSICAL AND MECHANICAL METALLURGY STUDIES ON DELTA-STABILIZED PLUTONIUM–GALLIUM ALLOYS. H. R. Gardner (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1965. Contract AT(45-1)-1830. 72p. Dep.; $3.00 (cy), 2(mn) CFSTI.

Studies of coring and homogenization in the Pu–1.0 wt % Ga delta-stabilized alloy indicated that: (a) the coring which occurs in the epsilon-plus-delta region is controlling for homogenization of the alloy and (b) the rate of homogenization is not only temperature-dependent but an inverse function of cored grain size which in turn is controlled by cooling rate through the epsilon-plus-delta region. X-ray line broadening and density-compression-density techniques were developed to permit estimation of state of homogenization. In a study of the metastability of the alloy with respect to pressure and subsequent annealing, it was found that (a) alpha-plus-delta phase mixtures in cored alloy were unstable during room temperature storage after annealing at temperatures below 280°C, while (b) alpha-plus-delta phase mixtures in homogenized alloy were stable under the same conditions. For gallium compositions ranging from 0.37 to 1.26 wt % in homogenized alloy, lattice parameter, density, and pressure metastability decreased, while hardness increased as gallium content increased. On 94% cold-rolled alloy, recrystallization occurred at 250°C. Possible stress relief and age hardening effects were noted. In addition, during extended anneals grain coarsening and grain boundary void formation were observed. During tensile and compressive testing at temperatures from –32 to 500°C, it was determined that strength decreased uniformly with temperature while ductility in general increased for low-iron alloy. As iron was increased, a hot short behavior was noted leading to a loss of strength and ductility. Testing speed up to 1.0 in./min at temperatures from –32 to 300 C had virtually no effect on strength or ductility. Strain hardening occurred in homogenized, cold-rolled alloy while the alpha phase formation in cored, cold-rolled alloy gave strengthening over and above that from strain hardening. The alpha phase formation also increased the modulus of elasticity. Several metallurgical conditions of alloy sheet were fatigue tested in cyclic flexure at room temperature. As the 0.2% yield strength increased from 11,000 to 32,000 psi, fatigue strength increased from 10,000 to 15,000 psi. The cored, as-cast, and homogenized, 94% wrought, 300°C annealed conditions had the lowest fatigue strength, while the cored, 86% wrought sheet had the highest fatigue strength. (auth)

26812 (CEA-Bib-54) ETUDE STRUCTURALE DES METAUX FONDUS PAR DIFFUSION DES RAYONS X. (Structural Study of Molten Metals by X-Ray Scattering). Michel Desjardins (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Mar. 1965. 27p. Dep.(mn).

The study of molten metals by the x-ray diffraction technique is not very advanced, due to the complexity of the theoretical equation and to the experimental difficulties arising from the recording of a high-temperature liquid x-ray diagram. The development of an exact theory, however, used in conjunction with electronic computers, and the improvement in analytical techniques have made it possible to determine a great number of structures, some very recently. This literature survey is divided into three main parts dealing with the general theory of x-ray scattering, apparatus and experimental results. (D.L.C.)

26813 (CEA-R-2715) ÉTUDE COMPARÉE DU COMPORTEMENT AU FLUAGE DE L'URANIUM ALPHA MONO ET POLYCRISTALLIN. (Comparative Study of the Creep Behaviour of Single Crystals and Polycrystals of α Uranium). Jean-Pierre Andre (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). 1965. 35p. Dep.(mn).

Thesis submitted to Paris Univ. (France).

A description is given of the creep machine developed to study the deformation of uranium at high temperature in vacuo with continuous recording. Results are presented concerning the polycrystals of uranium. The application of the DORN method gives an activation energy for creep of 42 ± 2 Kc, above 550°C, equal to the activation energy for self-diffusion. The study of the variation of the creep rate with the applied stress and the metallographic observations of the deformation-induced polygonization allow to conclude that the deformation is controlled by climb of dislocations. The deformation above 550°C of single crystals of uranium (obtained by $\beta \rightarrow \alpha$ change) is also studied. The major deformation mode is slip. The preexisting polygonization of these single crystals is very stable and the disorientation between adjacent subgrains increases with the deformation. The activation energy for creep is higher than that for polycrystals. These results show the influence of the polygonization due to the $\beta \rightarrow \alpha$ change on the creep behavior of α uranium. (auth)

26814 (CONF-650203-6) X-RAY DIFFRACTION FROM DEFORMED CERIUM. EFFECTS DUE TO EXTRINSIC STACKING FAULTS. Technical Report No. 11. Henry M. Otte (Martin Co., Orlando, Fla. Materials Research Lab.) and Henry Chessin (State Univ. of New York, Albany. Physics Dept.). Feb. 1965. Contract Nonr-3706(00). 21p. (OR-6427)

From National AIME Meeting, Chicago.

Preliminary measurements in the x-ray powder pattern of cold-worked cerium are reported. This data shows peak displacement in the Debye-Scherrer pattern in the direction predicted for relatively low probabilities of extrinsic stacking faults. (auth)

26815 (EURAEC-1195) THE RELATION BETWEEN TWINNING AND BRITTLE FRACTURE IN IRON AND IRON ALLOYS. E. Anderson and J. Spreadborough (Battelle Memorial Inst., Geneva (Switzerland)). 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract 095-62-12 RDS. 45p. (EUR-2034.f). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Metallographic studies indicate that the twinning behavior of iron and iron alloys can be discussed under two headings: twinning in fine-grained specimens; and twinning in coarse-grained specimens which are brittle or which exhibit ductile cleavage. In the case of the fine-grained samples twins appear around 150°K in the largest grains, being formed at the front of a Lüders band. As the temperature is lowered the number of twinned grains increases. The twinning stress is more dependent on the grain size than the stress necessary for deformation by slip, so that twinning in fine-grained specimens is accounted for by a simple yield propagation model. In specimens of the second group, deformed twins, and fine twins formed by the passage of cracks are observed. Since the oxygen content of the materials is quite high, and since the fractures of samples examined in the region of the ductile-brittle transition temperature were almost always of the mixed inter-intracrystalline type, it is felt that all the observed brittle fractures are intercrystalline in origin. (auth)

26816 (EURAEC-1334) DIFFUSION AND PRECIPITATION MECHANISMS OF HYDROGEN IN ZIRCONIUM AND ITS ALLOYS. Quarterly Report No. 3, September 1–November 30, 1964. (Bologna Univ. (Italy). Istituto di Fisica). Work Performed under United States–Euratom Joint Research and Development Program. Contract 026-64-3-TEE-I(RD). 21p. (EUR-2311). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Progress is reported in studies of recovery phenomena in Zr and structure of Zr oxides. Low-temperature electrical resistivity measurements were used to follow the isothermal recovery of Kroll-processed and high-purity Zr at 150 and 200°C. Logarithmic kinetics were observed for the Kroll Zr but not for the high-purity Zr. The formation of moire patterns upon the Zr were observed with an electron microscope as a means to follow the oxidation. (W.L.G.)

26817 (KAPL-3092) TEMPERING BEHAVIOR OF TWO PRESSURE-VESSEL STEELS. D. A. Ferrill, L. J. DiNuzzo, and R. H. Oberdick (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 15, 1965. Contract W-31-109-eng-52. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Two pressure-vessel steels (MIL-S-871, Class 2 and MIL-S-22494, Comp. A) were tested to determine the variation in hardness as a function of tempering temperature and time. The data obtained will aid in predicting changes in the hardness of these steels and their weld heat-affected zones during tempering and stress-relief treatments. (auth)

26818 (NAA-SR-8617(Vol.III)) SNAP TECHNOLOGY HANDBOOK. VOLUME III. REFRACTORY FUELS AND CLADDINGS. G. F. Burdi, comp. and ed. (Atomics International, Canoga Park, Calif.). Apr. 30, 1965. Contract AT(11-1)-Gen-8. 143p. $5.00(cy), 3(mn) CFSTI.

Currently available property data on high temperature nuclear reactor compounds (UC, UN, and UO_2), ceramic dispersions (Al_2O_3–UO_2 and BeO–UO_2), and cermet (Mo-UC, -UN, and -UO_2) fuels and potential claddings (Nb, Ir, Mo, Re, Ta, Ti, V, and W) are reported. (auth)

26819 (NMI-4787) PROPERTIES OF THE BERYLLIUM–ZIRCONIUM BRAZING ALLOY. R. R. Krom and A. R. Kaufmann (Nuclear Metals, Inc., West Concord, Mass.). Nov. 14, 1963. Contract AT(30-1)-2784 64p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A melting and casting procedure was developed for producing homogeneous castings of both zirconium- and Zircaloy-2 base alloys with low impurity contents of carbon and oxygen. The procedure consists essentially of melting and alloying together the charge materials in a graphite crucible by heating at 1100°C for one hour in a vacuum induction furnace. The density, fluidity, hardness, melting point, and microstructure were determined for each composition of braze alloy and the results are disccussed. (P.C.H.)

26820 (NUMEC-3428-9) GROWTH OF SINGLE CRYSTALS OF PLUTONIUM. Quarterly Progress Report, January 1–March 31, 1965. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Contract AT(30-1)-2389. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Progress is reported in the high pressure studies on α-Pu and strain-anneal studies on δ-Pu. (W.L.G.)

26821 (SWRI-1228-57) [PROGRESS REPORT ON TESTS OF LARGE PRESSURE VESSELS, JANUARY 18, 1965–MARCH 18, 1965]. Andrew G. Pickett (Southwest Research Inst., San Antonio, Tex.). Mar. 18, 1965. Contract AT(11-1)-1228. 11p. (SWRI-1228-58; SWRI-1228-59). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Progress is reported on cyclic pressure tests of large-size steel pressure vessels. (W.L.G.)

26822 (TID-20853) LOW-TEMPERATURE CHEMISORPTION OF GASES ON CLEAN METAL SURFACES. R. A. Pasternak, N. Endow, A. P. Brady, and B. Bergsnov-Hansen (Stanford Research Inst., Menlo Park, Calif.). [1963]. Contract [AT(04-3)-115]. 15p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

An ultrahigh vacuum study was made on the sorption of N_2, D_2, and Xe by Mo films and of Xe by glass in order to define better the different sorption mechanisms. Their significance in relation to gas pumping is also discussed. The results for each gas and a typical film are summarized. (P.C.H.)

26823 (TID-21843) THE TRUE STRESS-STRAIN PROPERTIES OF BRITTLE MATERIALS TO VERY HIGH TEMPERATURES. Final Report, 1963-1964. (Southern Research Inst., Birmingham, Ala.). Oct. 30, 1964. Contract AT(40-1)-2694. 95p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The work for this fiscal year (FY 1964) involved (1) the continued refinement and improvement of the stress-strain facility, (2) continued automation of the stress-strain facility, (3) the evaluation of refractory materials utilizing the stress-strain facility, (4) the implementing of the 6500°F graphite furnace for tensile strength studies within the temperature range of 5000–6500°F, (5) the design and development of a 5000°F tungsten furnace, and (6) the development of techniques and the implementation of the stress-strain facility to determine Poisson's ratio and shear properties of brittle materials. The performance of the stress-strain facility was greatly improved by several modifications and improvements to the optical strain analyzer and the strain measurement system. These and other past improvements permit the detection of strain to within an uncertainty of 0.00002 in. at this stage of the development. Initial efforts were made to provide the stress-strain facility with a system that will automatically control the strain rate of the specimen. The performance of this system was satisfactory and ultimately will be limited only by the noise of the strain analyzer itself. The tensile properties of a zirconium diboride–molybdenum disilicide material were investigated. The values of tensile strength, initial elastic modulus, and total strain to fracture were determined for both a hot pressed and a pressed and sintered material at several temperature levels from 70°F to 3650°F. The tensile strengths were in agreement with the flexural strengths at up to 2000°F but then a rapid loss in tensile strength was detected and attributed to silica probably in the grain boundaries. The 6500°F graphite furnace was implemented with a load train and the tensile properties of with-grain ATJ and pyrolytic graphite were investigated within the 5000°F to 6500°F temperature range. The first known values of tensile strength within this temperature range indicated quite high strengths. A large influence of strain rate on tensile strength was noted at the temperature levels of 6000°F and 6500°F. A tungsten furnace was designed and developed to permit operation to 5000°F in either a vacuum or inert atmosphere. The furnace design provided much lower power input and better overall performance and versatility than available previously for other high temperature tungsten furnaces. A performance run to 4000°F confirmed the excellent performance of the furnace and the validity of the new design concepts. Techniques were developed to allow the determination of Poisson's ratio and shear properties for brittle materials within the temperature range of 70–5000°F. For Poisson's ratio determinations, a lateral strain measurement system was developed to accurately record the small lateral strains of brittle materials when loaded in tension or compression. For shear property determination, a single shear specimen was developed that will permit the determination of both the shear modulus and shear strength when utilizing the stress-strain facility. (D.L.C.)

26824 (USBM-RC-1158) QUARTERLY METALLURGY PROGRESS REPORT NO. 26, JANUARY 1–MARCH 31, 1965. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Contract AT(11-1)-599. 20p. Dep.; $2.00(cy), 1(mn) CFSTI.

Hafnium carbide castings with total carbon contents from 8.5 to 11.5 wt % were tested for tensile properties at temperatures from 20 to 2180°C. Modulus of elasticity values were calculated for 20, 1100, and 1580°C. The preparation of homogeneous cermets by blending spheroidal thoria and thorium powder with suitable binders was attempted. The effect of organic binders on the carbon content, fabricability, and tensile properties of the cermet was investigated. No significant changes in fabricability or tensile properties were noted for an increase in carbon content from 0.1 to 0.6%. Studies were conducted on the sintering of the UC–UO system in an attempt to minimize both decomposition and back-reactions with carbon monoxide. Hydriding and dehydriding uranium powders resulted in a finer powder but the oxygen content was increased substantially. (W.L.G.)

26825 (FTD-TT-64-1145) CRYSTAL STRUCTURE OF Sr_6Li_{23} COMPOUND. P. I. Kryp'yakevych (Krypyakevich) and H. I. Oleksiv. Translated from Dopovidi Akad. Nauk Ukr., RSR, No. 11, 1489-91(1963). 4p. CFSTI.

Strontium/lithium alloys, the composition of which (66.7, 79.3, and 89.5 atomic % Li per batch), corresponded to compositions of possible compounds were prepared and their crystalline structure was investigated by the x-ray structural method (chrome radiation, Debye chamber). An intensity calculation, made for Th_6Mn_{23} type (spatial group) Fm_3m-05h; 24 Sr in 24 (e), with x = 0.203, 92 Li in 4 (b), 24 (d), 32 (f), with x = 0.378 and 32 (f), with x = 0.178, confirmed the existence of an Sr_6Li_{23} compound and the appurtenance of same to this type. Data are tabulated. (P.C.H.)

26826 WETTING OF SEVERAL SOLIDS BY Al_2O_3 AND BeO LIQUIDS. R. W. Bartlett and J. K. Hall (Philco Research Labs., Newport Beach, Calif.). Am. Ceram. Soc. Bull., 44: 444-8(May 1965).

Contact angles of liquid Al_2O_3 and liquid BeO on several refractory substrates were measured using the sessile drop technique. Changes in contact angle were recorded with motion picture photography. Chemical behavior liquid/solid interfaces was studied using x-ray diffraction of cooled droplets and microscopic and electron microprobe examination. (auth)

26827 SOME REMARKS ON THE VALIDITY OF THE WIEDEMANN-FRANZ-LORENZ LAW FOR THE STAINLESS STEEL AISI-316. R. Evangelisti, F. Isacchini, and A. Premoli (CNEN, Rome). Energia Nucl. (Milan), 12: 266-72(May 1965).

This experimental investigation enables one to evaluate the accuracy limits of the information obtained by the Wiedemann-Franz-Lorenz law on the thermal conductivity of the stainless steel AISI-316. The free electrons theory leads to a Lorenz number value which is lower than the values calculated from the experimental data, in the temperature range 100-1000°C. The results are then compared with the values of the Powell equation, proposed as a modification of the Wiedemann-Franz-Lorenz law for iron alloys. (auth)

26828 MAGNETIC PROPERTIES OF Er–Y ALLOY. V. I. Chechernikov, I. Pop, and I. A. Markova (Moscow State Univ.). Fiz. Metal. i Metalloved., 19: 290-3(Feb. 1965). (In Russian)

Magnetic properties of eight Er–Y alloys of 2 to 70 at. % Y were studied. Sample preparation is described. Results of measurements of the variation of magnetic susceptibility with temperature are given for the different alloy compositions and for temperatures from 77 to 1100°K. The effective atomic magnetic moments and the paramagnetic Curie temperatures were derived for the various alloy compositions. (M.J.T.)

26829 STRENGTH AT THE BRITTLE RUPTURE OF THE STEEL PLATE FOR USE IN THE CONSTRUCTION OF THE PRESSURE VESSEL OF THE 1ST POWER REACTOR. Hiroshi Kihara (Tokyo Univ.) and Kazuo Ikeda. High Pressure (Tokyo), 2: No. 5, 21-8(Sept. 1964). (In Japanese)

The strength at initiation of brittle rupture of steel plate used in construction of pressure vessels was investigated to find a suitable temperature for the pressure test of the vessel and also the temperature rise of the transition state due to neutron irradiation. By Robertson tests on the plates, the critical temperature, at which the propagation of cracks in the plate ceases, was investigated. The stress was applied to the plate sample by hammering. The temperature gradient in the plate was observed by thermocouples welded at twelve places. The transition temperature was found to be 6°C. The pressure test of the vessel was carried out with a minimum temperature of 20°C, 14°C above the transition temperature. In the pressure test, no hair cracks were produced over the vessel shell. (NSA of Japan)

26830 EVALUATION AND PROSPECTS FOR THE USE OF ZIRCONIUM AND ITS ALLOYS. Georges Simonovitch. Ind. At., 9: Nos. 1-2, 49-55(1965). (In French)

Zirconium has rapidly taken its place among the construction materials used in atomic engineering. Today zirconium and its alloys are used as cladding for fuel elements, in pressure tubes, and for various other parts of many reactors. The physical, mechanical, and nuclear

properties of Zr, together with it properties of resistance to corrosion in various attacking media, are described. The present limitations of Zr and the preferential regions of its use are defined. The progress realized by the development of new alloys for increasing atomic applications is discussed. (tr-auth)

26831 X-RAY DIFFRACTION EVIDENCE FOR MICROPHASES IN $CeCd_{\sim 4.5}$ SOLID SOLUTIONS. Raymond B. Roof, Jr. and Guy R. B. Elliott (Los Alamos Scientific Lab., N. Mex.). Inorg. Chem., 4: 691-7(May 1965). (LA-DC-6140)

If the actual composition of a compound differs from that associated with the crystallographically ideal structure, then defects are created in the lattice. In the $CeCd_{4.3-4.7}$ region such defects may be randomly distributed throughout the lattice as was previously shown by vapor pressure measurements. In addition, the defects may order into many true phases, which break up the random solution into ordered structures separated by two-phase regions. The ordered structures are called microphases and their existence was confirmed by x-ray diffraction results. All the superlattices observed may be classified by four characteristic key patterns, which appear over wide areas between the reciprocal lattice spots of the parent structure. The superlattices appeared to be orthorhombic, hexagonal, or monoclinic and could be correlated with vapor pressure measurements. All parent lattice distances were the same in the a axis direction. A hexagonal superlattice unit cell with a axis distance ~126 Å, c axis distance ~15.46 Å was identified. The c axis parent lattice distance was ~15.55 Å at $CeCd_{4.33}$ but decreased by ~0.6% as the composition shifted to $CeCd_{4.65}$. The decrease in the c axis followed approximately the decrease of 0.64% in the electron/atom ratio, but the usual Brillouin zone argument seemed inadequate to explain the shift for two reasons: first, the unchanging a axis distance was unusual and second, the apparently different superlattice symmetries would create different Brillouin zone shapes. (auth)

26832 DIFFUSION OF NONVOLATILE METALLIC ELEMENTS IN GRAPHITE. James R. Wolfe (Oklahoma State Univ., Stillwater), Donald R. McKenzie, and Richard J. Borg. J. Appl. Phys., 36: 1906-17(June 1965).

The diffusion coefficients for Ag, Ni, U, Th, and Ra diffusing in various types of graphite were determined as a function of temperature. Good precision is obtained in all cases and the corresponding activation energies are reported. These values, when comparison is possible, do not agree with values previously reported. An explanation is given for the lack of agreement based upon the relative insolubility of metals in graphite. Experimental evidence is presented which indicates that substitutional, pore, and interstitial diffusion are inoperative and that all mass transport proceeds solely via grain and subgrain boundaries. The activation energies and frequency factors are explained by a diffusion model involving widely spaced traps which are situated at imperfections. (auth)

26833 THERMOELECTRIC PROPERTIES OF NIOBIUM IN THE TEMPERATURE RANGE 300°–1200°K. V. Raag and H. V. Kowger (Radio Corporation of America, Harrison, N. J.). J. Appl. Phys., 36: 2045-8(June 1965).

The electric resistivity, thermal diffusivity, and Seebeck coefficient of niobium were measured from 300–1200°K. Using measured values of thermal diffusivity and literature values of specific heat, the thermal conductivity was calculated for the same temperature range. The Lorenz number is 2.75×10^{-8} W-Ω-deg^{-2} and is independent of temperature. The absolute Seebeck coefficient is very close to zero, its largest magnitude being −2.6 μv/°K and occurring at 450°K. Data are also presented on the Seebeck coefficient of tungsten up to 1400°K. (auth)

26834 RESISTIVITY AND TEMPERATURE COEFFICIENT OF PURE MOLYBDENUM. R. A. Holmwood and R. Gland (IBM Components Div., Poughkeepsie, N. Y.). J. Chem. Eng. Data, 10: 162-3(Apr. 1965).

The resistivity and temperature coefficient of 99.999% molybdenum, zone purified in vacuum and nearly monocrystalline, were measured. The resistivities were 5.00 μΩ cm at 0°C, 5.57 μΩ cm at 25°C and 740 μΩ cm at 100°C with a maximum error of +1.0, 0.5%. Between 0 and 100°C, the resistivity increased more than linearly. The closest linear approximation in this range was obtained with an average resistivity coefficient of 0.00482/°C. The ratio of resistivities at −196 and 0°C was 0.097. Comparison with data published previously indicated a purity of the material investigated, which was higher than that of former single crystals as well as spectroscopically pure products. (auth)

26835 BERG-BARRETT X-RAY-MICROSCOPE STUDIES OF A NIOBIUM SINGLE CRYSTAL. A. V. Narlikar (Cambridge Univ., Eng.). J. Inst. Metals, 93: 327-8(May 1965).

Preliminary results of Berg–Barrett x-ray microscopic studies of a niobium single crystal are described. A high dislocation density was observed in the crystal and the microstructure consisted mainly of sub-grain boundaries. After annealing for 15 hr close to the melting point and electropolishing, Berg–Barrett micrographs showed no dislocations or other defects. After pressing the crystal lightly against a plasticine ball, dark contours were observed running along different directions. It was concluded that Berg–Barrett x-ray microscopy can be used to study individual dislocations in niobium only when the crystal possesses a low dislocation density and contrast effects are in general strong, near a Bragg contour produced by the local bending of the crystal. (M.C.G.)

26836 ELECTRONIC FACTORS AND THE METASTABLE CONSTITUTION OF QUENCHED ALLOYS BASED ON TITANIUM AND ZIRCONIUM. C. A. Luke (Lockheed Aircraft, Sunnyvale, Calif.), R. Taggart, and D. H. Polonis. J. Nucl. Mater., 16: 7-18(May 1965).

The relationship between the metastable constitution of quenched alloys based on titanium and zirconium and the corresponding electron-atom ratio was investigated from the viewpoint of the electron theory of metals. The first and second Brillouin zones for the alpha, beta, and omega phases of titanium and zirconium were calculated and compared from the standpoint of their respective abilities to accommodate the electrons involved in alloy solid solutions. The calculations of the Brillouin zones for the omega phase were not reported previously and are based on x-ray results for Zr–V and Zr–Ni alloys. The relative stabilities of the alpha, beta, and omega phases were compared on the contention that if electronic factors assume a predominant role in determining the total free energy of these phases, then the principal factor determining stability (or metastability) is minimization of the Fermi energy. (auth)

26837 THE EFFECT OF COOLING RATE ON THE DECOMPOSITION OF THE γ-PHASE IN URANIUM–ZIRCONIUM ALLOYS. R. F. Hills, B. R. Butcher, and B. W. Howlett (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 16: 25-38(May 1965). (AERE-R-4557)

Rods of uranium-zirconium alloys containing from 2.5 to 50 at. % zirconium were end-quenched, and the phases formed, their distribution, and their hardness were examined as a function of composition and cooling rate. It was found that the ω-phase, or metastable non-stoichiometric disordered ε-phase, plays a large part in the decomposition of the alloys containing 30 to 50 at. % zirconium, and it is suggested that it is also very important in decomposition of alloys containining from 10 to 30 at. % zirconium, although in those alloys examined in this range, the ω-phase could not be retained to room temperature. In the more dilute alloys there was no sign of its appearance. Not enough is known about the mechanism of formation of this phase to suggest unequivocal decomposition schemes, but suggestions about the various possibilities are made. (auth)

26838 KINETICS OF THE $\alpha \rightleftharpoons \beta$ TRANSFORMATION OF PLUTONIUM IN THE NEIGHBORHOOD OF EQUILIBRIUM. B. Spriet (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Nucl. Mater., 16: 59-67(May 1965). (In French)

The kinetics of the $\alpha \rightleftharpoons \beta$ transformation in plutonium were examined in the neighborhood of the equilibrium temperature. The form of the isotherms, and in particular the athermal character of the transformation, are explained by the presence of internal stresses caused by the volume change accompanying the transformation. From analysis of these curves the laws of transformation were deduced: thus the activation energy was 33 kcal/mole for $\alpha \rightarrow \beta$ and 4.6 kcal/mole for $\beta \rightarrow \alpha$, remote from equilibrium. The results suggested that according to the experimental conditions the transformation may proceed by either of two mechanisms. Near the equilibrium temperature, the $\alpha \rightleftharpoons \beta$ transformation proceeds by diffusion; under other conditions it proceeds by shear. These conclusions permitted all the characteristics of the $\alpha \rightleftharpoons \beta$ transformation to be interpreted. (auth)

26839 OBSERVATIONS ON THE FRACTURE OF ZIRCALOY-2 AND Zr–2.5% Nb. G. Oestberg and B. Lehtinen (Aktiebolaget Atomenergi, Stockholm). J. Nucl. Mater., 16: 79-83(May 1965).

Tests were made on Zircaloy-2 and Zr–2.5 wt % Nb to assess the tendency to rapid failure as a function of temperature and hydrogen content. Fracture surfaces were examined in an electron microscope on replicas taken from different areas of the surfaces. The ductile type of fracture, characterized by dimples, was predominant among the varieties of fracture appearance observed, particularly in Zr–2.5% Nb. In Zircaloy-2, but not in Zr–2.5% Nb, there was a larger proportion of ductile fracture near the surface than in the interior. A typical hydride fracture is shown and proof of its origin offered. The hydride fractures were rather frequent, covered relatively large areas, and were associated with either ductile or nonductile matrix fracture. Intergranular fractures were also frequent. (M.C.G.)

26840 ON SEGREGATION IN SOLID-LIQUID SYSTEM UNDER THE ACTION OF A TEMPERATURE GRADIENT. H. Nadler and H. Wiedersich (North American Aviation Science Center, Thousand Oaks, Calif.). J. Nucl. Mater., 16: 84-6(May 1965).

Some experiments in which segregation in a temperature gradient occurred in a system with initially the same average composition throughout are described. The major transport mechanism appeared to be convection rather than diffusion. The specimens were substoichiometric UC rods. This compound consists of a uranium-rich liquid phase and solid UC of closely stoichiometric composition. On heating the segregation occurred over a distance of about 0.1 cm. Typical microstructure is shown (M.C.G.)

26841 THE INTERMETALLIC COMPOUNDS $PuGa_4$ AND $PuGa_6$. C. C. Land, F. H. Ellinger, and K. A. Johnson (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 16: 87(May 1965). (LA-DC-6791)

Work on alloys containing more than 75 at. % gallium revealed the existence of the intermediate phases $PuGa_4$ and $PuGa_6$. X-ray results indicated that the 420°C isotherm corresponded to the peritectic reaction $L + PuGa_3 \rightleftharpoons PuGa_4$ and that the 321°C isotherm corresponded to the peritectic reaction $L + PuGa_4 \rightleftharpoons PuGa_6$. $PuGa_4$ was found to be a body-centered orthorhombic, space group Imma and 4 $PuGa_4$/unit cell with a = 4.380 ± 0.001, b = 6.290 ± 0.001, and c = 13.673 ± 0.004 Å. For $PuGa_6$ the powder data corresponded to that of a primitive tetragonal unit cell with a = 5.942 ± 0.001 and c = 7.617 ± 0.001 Å with two formula weights per unit cell. (M.C.G.)

26842 ON THE ORIGIN OF THE STRAIN FIELDS AROUND THE ALUMINA PARTICLES IN Al–Al_2O_3 SAP FOILS. E. Ruedl and E. Staroste (Euratom, Ispra, Italy). J. Nucl. Mater., 16: 103-8(June 1965).

Electron microscopy and electron diffraction techniques were used to study the origin of the strain fields around the alumina particles in Al–4 wt % Al_2O_3 SAP foils. The foils were prepared by rolling, annealing at 640°C, and subsequent cooling to ambient temperature at different rates. In quenched foils the strain around the aluminum particles became so large that it was generally relieved by plastic flow of the aluminum matrix. In foils cooled in one minute or more slowly, well-defined strain fields were observed and could be analyzed by the method of Ashby and Brown. It was found that the strain increased with the rate of cooling and that it was due to differential thermal contraction effects rather than to coherency. The role played by thermal contraction was shown for the smaller alumina by comparing the measured strain parameter ϵ with ideal values; for the larger alumina it was implied by the rareness of structural relationships, which may lead to coherency, between the alumina and matrix. (auth)

26843 THE EFFECT OF COOLING RATE AND COMPOSITION ON THE TRANSFORMATION OF THE GAMMA-PHASE IN URANIUM–RUTHENIUM ALLOYS (WITH AN APPENDIX ON RUTHENIUM AS A GRAIN-REFINING ELEMENT). R. F. Hills (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.), B. W. Howlett, B. R. Butcher, and D. Stewart. J. Nucl. Mater., 16: 109-28 (June 1965). (AERE-R-4722)

The transformations, which take place when uranium–ruthenium alloys containing 1 to 10 at. % ruthenium are cooled from the γ-phase field were studied by an end-quenching technique. At the quenched ends, most of the series of metastable phases that occur in other uranium alloys quenched from the γ-phase were found, except for the monoclinic α-type structure α_b''. Beyond the quenched ends, the decomposition was dominated by the rapid diffusion of ruthenium to form U_2Ru. Decomposition schemes are suggested. Most of these are straightforward, but in alloys containing around 2.5 at. % ruthenium, it was necessary to postulate a massive mode of formation of β-phase from γ to account for the simultaneous appearance of β-phase with one of the martensitic α-phases formed directly from γ in the quenched ends. An appendix on the grain refinement achieved by isothermal transformation of the dilute alloys from the β-phase to the α is included. (auth)

26844 PLASTIC DEFORMATION IN UNIAXIAL TENSION OF MONOCRYSTALLINE AND POLYCRYSTALLINE URANIUM BETWEEN 20 AND –196°C. A. Lemogne and P. Lacombe (École des Mines, Paris). J. Nucl. Mater., 16: 129-45(June 1965). (In French)

Tensile tests at low temperatures (–196 to 20°C) were performed on single crystals and polycrystals of uranium. At –196°C, the elongation to fracture depended essentially on the deformation mechanisms. The absence of (010)–[100] slip was found to considerably enhance ductility. The mechanical properties of the polycrystals, fracture stress and elongation to fracture, deteriorated when the test temperature was lowered from 20 to –196°C; the temperature and sharpness of the fracture transition depended on the grain size. On the other hand, it was found that the Petch relationship applies to a good approximation to the flow stress and the fracture stress. The effect of the temperature on the constants in this relationship was examined. Finally, experiments bearing on the deformation to rupture at –196°C of polycrystalline samples prestrained at 20°C showed the importance of intergranular rupture on the plastic behavior of uranium. (auth)

26845 DETERMINATION OF THE MICRO-HOMOGENEITY OF UO_2/PuO_2 SINTERED FUEL PELLETS BY AUTORADIOGRAPHY. M. R. H. Hill and C. E. Mellish (Atomic Energy Research Establishment, Wantage, Berks, Eng.). J. Nucl. Mater., 16: 155-61(June 1965).

The microhomogeneity of UO_2/PuO_2 sintered fuel pellets was determined autoradiographically from data obtained from the "stars" produced by high local concentrations of PuO_2. The method involves counting of the α tracks in the stars, which are of projected length greater than a certain fraction, x, of the maximum track length, R_e, in the emulsion. The value of x chosen, 0.4 R_e, limits the depth of the section being examined and is a compromise between obtaining the thin section required by the method used in interpreting the results, and obtaining a reasonable number of tracks. The number of tracks, of length $x \geq 0.4\ R_e$, associated with particular "stars" is used to calculate the volume of PuO_2 in the sectioned particles and the true particle size distribution in the fuel calculated from the size distribution of the sectioned particles in the plane of ob-

servation. The final results are in the shape of statistical information about the particles as an assembly, and not about individual particles. The method gives a semi-quantitative picture of the particle size distribution and is applicable to loadings of up to 3 wt % $^{239}PuO_2$. (auth)

26846 PHASE EQUILIBRIA IN THE SYSTEM VANADIUM OXIDE–NIOBIUM OXIDE. J. L. Waring and R. S. Roth. J. Res. Natl. Bur. Std., 69A: 119-29(Mar.–Apr. 1965).

The phase diagram for the pseudo-binary system V_2O_5–Nb_2O_5 was constructed from fusion characteristics and x-ray diffraction data. Three compounds were postulated for the system. The compounds VNb_9O_{25} and $V_2Nb_{22}O_{62}$ were found to melt incongruently at about 1290 and 1322°C, respectively. The third compound occurring at about 93 to 94 mole % Nb_2O_5 melted incongruently at approximately 1332°C. Apparently, Nb_2O_5 accepted up to 5 mole % V_2O_5 in solid solution, however, V_2O_5 did not accept any appreciable Nb_2O_5 in solid solution. In addition, the Nb_2O_5 rich portions of the following binary systems were reinvestigated: ZnO–Nb_2O_5, NiO–Nb_2O_5, Al_2O_3–Nb_2O_5, TiO_2–Nb_2O_5, and ZrO_2–Nb_2O_5. In each case an Nb_2O_5 solid solution was reported previously in excess of 90 mole % Nb_2O_5. However, subsequent data indicated that these Nb_2O_5 solid solutions contained discrete compounds related to those found in the pseudo-binary V_2O_5–Nb_2O_5. (auth)

26847 THE URANIUM–URANIUM DIOXIDE PHASE DIAGRAM AT HIGH TEMPERATURES. Allan E. Martin and Russell K. Edwards (Argonne National Lab., Ill.). J. Phys. Chem., 69: 1788(May 1965).

The U–UO_2 phase diagram at 1200 to 3000°C is shown. No solid phases intermediate to urania and liquid uranium in the system were evident. The existence of a liquid miscibility gap of substantial width was established. The monotectic composition was established as 65 ± 5 mole % of UO_2. The monotectic temperature was 2500 ± 30°C. (M.C.G.)

26848 STUDY OF NEW NIOBIUM-BASE ALLOYS. METHODS USED. FIRST RESULTS OBTAINED. R. Syre, R. Cousserans, and R. Molinier. Metaux (Corrosion-Ind.), 39: 305-24(Sept. 1964). (In French)

Heat-resistant Nb alloys and the practical development of these alloys were studied. The methods and devices used for the study of the alloys are briefly described. The principal results obtained on binary alloys of Nb with Fe, Ni, Co, and Mo + Cr, on quaternary alloys containing Ti, V, and Zr, and on Nb with ThO_2 in dispersion are reported. Data on the fusion, transformation, thermal hardness, and oxidation velocities of these alloys were tabulated. (J.S.R.)

26849 THE ELECTRON BEAM MELTING OF REFRACTORY METALS. I. THE ELECTRON BEAM MELTING AND BRITTLE FRACTURE OF METAL MOLYBDENUM. Tetsuya Takaai (Hitachi Engineering Works, Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 28: 670-6(1964). (In Japanese)

The electron-beam melting and brittle fracture of molybdenum was studied using a 60-kw electron beam melting furnace, testing machines, and the s-ray Laue back-reflection procedure. The crystal grains of electron-beam-melted molybdenum were extraordinarily large in size and thick, and about 100-mm-long columnar grains were observed in a 30-mm-dia ingot. These grains, which grew columnar-like, had a certain degree of orientation preference. The molybdenum in the as-cast state exhibited a typical brittleness and the fractured surfaces were principally grain boundaries except for cleavage fractures of (100) planes. Accourding to the spectrographic analysis, the volatile metallic impurities were released preferentially as expected from their vapor-pressure data. Those metallic impurities, which had relatively higher melting points and lower vapor pressures, were rather abundant in the melted molybdenum. Although C, O, and N were not determined, the tensile stress-strain diagram of an electron-beam-melted molybdenum wire showed almost no yielding behavior. Therefore, it was assumed that the electron-beam-melted molybdenum had the least amount of interstitial impurities. The brittle fracture strength was remarkably increased with frequency of the melting operation. (auth)

26850 THE ELECTRON BEAM MELTING OF REFRACTORY METALS. II. STUDIES ON THE GRAIN BOUNDARY INCLUSIONS OF ELECTRON BEAM MELTED MOLYBDENUM. Tetsuya Takaai (Hitachi Engineering Works, Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 28: 676-83(1964). (In Japanese)

The grain boundary inclusions of electron-beam-melted molybdenum were studied by fractographic method using electron and optical microscopes. A great many fine precipitates were found in the fractured boundaries. These boundary inclusions substantially decreased and became smaller in size on increasing the melting operation from one to 5 times. But brittle fracture still occurred at grain boundaries and a good many fine precipitates of 0.2 to 0.3 μ size were found. The lattice spacings of the extracted boundary inclusions were determined to be molybdenum carbide Mo_2C. Those specimens containing a good many inclusions were heated in vacuum at 1500 to 2000°C and 2 to 1×10^{-4} mmHg for 1 hr. But the inclusions did not change substantially and the diffracted patterns were identical with those of the initial specimens. The grain boundary surfaces of those specimens pretreated in hydrogen flow and then electron-beam melted were fine and clear, and the boundary inclusions were smaller than the non-treated. On the other hand, the electron-beam-melted molybdenum with carbon additions had very fine crystal grains and fractured mainly trans-granularly, but the fractures in grain boundaries were hardly observable. The electron diffraction test showed that those boundary inclusions in carbon added molybdenum were also molybdenum carbide Mo_2C. No oxide diffraction patterns were found from the extracted grain boundary inclusions. (auth)

26851 ELECTRICAL RESISTIVITY OF METALLIC LITHIUM VAPOR. Axel Meyer, C. W. Nestor, Jr., and W. H. Young (Oak Ridge National Lab., Tenn.). Phys. Rev., 138: A1591-3(June 14, 1965). (ORNL-P-892)

The electric resistivity of Li vapor in the metallic phase is calculated using hard-sphere ion-ion interactions and an electron-ion scattering amplitude obtained using the pseudopotential technique. An upper limit on the density at which the transition from the metallic state is expected to take place is estimated to be 2.2×10^{22} atoms/cc. (auth)

26852 DIFFUSION IN THE BINARY ALLOY MOLYBDENUM–TUNGSTEN. D. F. Kalinovich, I. I. Kovenskii, and M. D. Smolin. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 4, 79-82(Apr. 1965). (In Russian)

The diffusion of both components of the alloy molybdenum-20 at. % tungsten was investigated. Radioisotopes ^{99}Mo and ^{185}W were used in the experiments. It is shown that the values of the diffusion coefficients of both molybdenum and tungsten lie on the straight line of the dependence of logarithm of diffusion on the reciprocal of the temperature throughout the investigated temperature range (1700 to 2300°C for molybdenum and 1500 to 2200°C for tungsten). The pre-exponential multipliers and the diffusion activation energy were determined for both metals. (auth)

26853 OBSERVATIONS ON THE EFFECT OF VACUUM HEAT-TREATMENT (UP TO 4000°F) ON DISPERSIONS OF VARIOUS OXIDES, NITRIDES, AND BORIDES IN MOLYBDENUM. J. E. White (Aerospace Corp., El Segundo, Calif.). Powder Met., 8: No. 15, 64-80(1965).

The compatibility between molybdenum and several refractory compounds present as dispersed phases in the 3000 to 4000°F (1650 to 2210°C) temperature range was evaluated. Compounds included in the study were BN, ZrN, HfN, LaB_6, ZrB_2, TaB_2, Y_2O_3, NgO, ZrO_2, and ThO_2. Hot-pressed alloys, consisting of nominally 2.5 vol % of the refractory phase in a molybdenum matrix, were vacuum-annealed to determine elevated-temperature stability. The evaluation was based on changes in grain size, dispersed-phase morphology, hardness, and gross macroscopic deterioration. The materials HfN, ZrO_2, and ThO_2 showed promise for dispersion-strengthening and were recommended for further development. (auth)

26854 ThO_2–DISPERSION-STRENGTHENED NICKEL AND NICKEL–MOLYBDENUM ALLOYS PRODUCED BY SELECTIVE REDUCTION. Jens G. Rasmussen (Massachusetts Inst. of Tech., Cambridge) and Nicholas J. Grant. Powder Met., 8: No. 15, 92-113(1965).

A series of Ni–ThO_2 and Ni–12% Mo–ThO_2 system containing from 3 to 9 vol % thoria, were prepared by selective hydrogen reduction of mixed submicron oxides. Room-temperature strength properties considerably higher than usual, with good ductility, were obtained. At 982°C, creep-rupture properties were excellent, with significant improvements in strength and stability due to solid-solution strengthening of nickel by 12 wt % molybdenum. An investigation was made of the benefits derived from additional cold work after hot extrusion, with and without intermediate annealing treatments. An analysis of the probable strain distribution in oxide-dispersion-strengthened alloys is presented. (auth)

26855 THE DETECTION OF DISLOCATIONS IN TUNGSTEN AND MOLYBDENUM BY ELECTROLYTIC ETCHING. Erwin Pink (Metallwerk Plansee AG, Reutte/Tirol, Austria). Prakt. Metallog., 2: 58-63(Apr. 1965). (In German)

An electrolytic etching technique proved to be suitable for the development of etch-pits, i.e., the traces of dislocation lines on crystal surfaces. The ELYPOVIST apparatus allows determination of optimal electric data due to the possibility of direct observation during etching. Conditions for polishing and etching are mentioned for the metals tungsten and molybdenum and examples are shown. (auth)

26856 THE ELECTRIC CONDUCTIVITY OF PURE ZIRCONIA BETWEEN 1200°C AND 1750°C. A. Guillot and A.-M. Anthony (C.N.R.S., Bellevue, France). Rev. Hautes Temp. Refractaires, 1: 325-9(Oct.-Dec. 1964). (In French)

The electric conductivity of unstabilized pure zirconia was determined between 1200 and 1750°C under oxygen pressures varying from 1 to 10^{-6} atm. Between 1200 and 1400°C, there is semi-conduction by impurities; and between 1600 and 1750°C, there is conduction by the zirconia itself. Between 1400 and 1600°C, conduction occurs by both processes. (auth)

26857 DIFFUSION OF NICKEL IN NIOBIUM. T. K. Yatsenko and L. F. Chernaya. Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 19, 183-6(1964). (In Russian)

Diffusion of 99.98% pure nickel into niobium was studied at 950 to 1100°C. (R.V.J.)

26858 CONSTITUTION DIAGRAM OF $NbCr_2$–$TiCr_2$ AND $NbCr_2$–Ti. V. N. Svechnikov, Yu. A. Kocherzhinskii, and V. I. Latysheva. Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 19, 192-5(1964). (In Russian)

Phase diagrams were constructed for a chromium alloy with 6.5% Nb and 34% Ti and for a chromium alloy with 10% Nb and 31% Ti at 1280 to 1540°C. (R.V.J.)

26859 CONSTITUTION DIAGRAM OF NIOBIUM–NICKEL ALLOY. V. N. Svechnikov, V. M. Pan, and V. G. Korobeinikov. Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 19, 196-205(1964). (In Russian)

Phase diagrams were constructed for Nb–Ni alloys and mechanical properties were studied at 1000°C. It was found that additions of Ni increased the hardness of the niobium. However, this feature did not hold at high temperature (800 to 1000°C). (R.V.J.)

26860 DUCTILITY OF YTTRIUM-ALLOYED CHROMIUM. V. N. Gridnev, R. K. Ivashchenko, Yu. V. Mil'man, and V. I. Trefelov. Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 20, 25-31(1964). (In Russian)

The introduction of yttrium into chromium caused not only an increase in the heat resistance of chromium but also a substantial increase in ductility. The decrease of the temperature of cold brittleness (T_x) was observed only after this alloying, since in the plastic deformation studies the lattice of the inclusions was broken at grain boundaries. Cold plastic deformation (lower temperature of recrystallization) caused substantial decrease in T_x in the presence of a simultaneous increase in stability. (tr-auth)

26861 STRUCTURE AND PROPERTIES OF Mo–Si–Cr ALLOYS. V. N. Svechnikov, Yu. A. Kocherzhinskii, and Yu. M. Yupko. Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 20, 94-107(1964). (In Russian)

By x-ray structure analysis, the isotherm profiles were plotted for Cr–Mo–Si at 1500°C (in the range Mo–Cr–Cr_5Si_3–Mo_5Si_3) and at 1300°C (in the range (Mo–Cr–$CrSi_2$–$MoSi_2$). The presence of continuous solutions of the silicides Mo_3Si–Cr_3Si and Mo_5Si_3–Cr_5Si_3 was established and the discontinuity of the solutions between the silicides $CrSi_2$ and $MoSi_2$, along with the formation of three compounds, occurred with percentages near 17.7 to 19.7 wt % Mo and 26.5 to 28.3 wt % Si. The experimental method and structure of the experimental arrangement for investigation of the sinterability of the systems by simultaneously forming volatile and non-volatile oxides was worked out. The sinterability of the binary Cr–Mo alloy system at 1000°C was investigated. It was established that the addition of 30% Mo does not impair the sinterability of Cr, but the addition of 40% Cr to Mo does not improve it. The sinterability of the binary system Mo–Si at 1000°C was investigated. It was established that for the protection of Mo from oxidation in surface layers, probably not less that 30% Si was necessary. The sinterability of systems formed from disilicides of Mo and Cr ($MoSi_2$–$CrSi_2$) at 1000°C was investigated. It was established that the addition of Cr impaired the properties of $MoSi_2$. The properties of the ternary system Cr–$MoSi_2$ at 1000°C were investigated. It was established that the joint addition of Mo at 30% and Si at 17.5% does not reduce the sinterability of Cr. Systems of Cr, containing about 30 to 35% Mo and 17.5 to 20.5% Si, have low sinterability. (tr-auth)

26862 PHASE DIAGRAM FOR Cr–Nb–Ti ALLOYS. Yu. A. Kocherzhinskii and V. I. Latysheva. Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 20, 125-9(1964). (In Russian)

Phase diagrams were constructed for ternary Cr–Nb–Ti alloy specimens prepared from electrolytically refined Cr, titanium, iodide and 99.5% pure Nb annealed at 1250°C for 75 hr. (R.V.J.)

26863 LOW TEMPERATURE INTERNAL FRICTION OF URANIUM–0.4 w/o MOLYBDENUM ALLOY. Genjiro Mima and Masaharu Hasegawa (Osaka Univ.). Technol. Rept. Osaka Univ., 14: 721-44(Oct. 1964).

The low-temperature internal friction of uranium-0.4 wt % molybdenum alloy subjected to various heat treatments was measured in order to explain the behavior of molybdenum atoms in the alloy and to study the swelling of uranium alloy fuels. On the internal friction-temperature curves of the alloy three maxima, at 120, 150, and 230°K, were discovered in temperature range from 77 to 360°K, and on the curves of pure uranium only the 150°K peak was noticed. The 120°K peak appeared in the alloy β-quenched or tempered at lower temperatures than 350°C whose structure was homogeneous solid solution, and a trace of the peak remained as a shoulder at the peak temperature when the alloy was subjected to the higher-temperature annealings or temperings. The 150°K peak appeared only under annealed or fully tempered conditions under which the alloy was constructed from the dilute solid solution and the uranium-molybdenum intermetallic compound, and was lost entirely at the β-quenched state. And the 230°K peak was caused by β-quenching and disappeared on tempering for 1 hour at 100°C. It was concluded that the 120°K peak may be produced by an interaction of dislocations and complex point defects combined with molybdenum atoms. The 150°K peak was the same relaxation maximum as the 150°K peak in pure uranium and may be caused by the interaction of dislocations with relatively stable complex point defects combined with impurities but not combined with molybdenum atoms, and the 230°K peak may be produced by an interaction between dislocations and some thermally unstable point defects. The Young's modulus of the alloy decreased abruptly on β-quenching and recovered during the following room-temperature aging. The rate formula of the recovery agreed well with the martensitic transformation theory and the nucleation theory. (auth)

26864 STRUCTURAL PROPERTIES OF d AND f METAL HYDRIDES. Bjoern Pedersen (Universitetet, Oslo). Tidsskr. Kjemi, Bergvesen Met., 25: 63-72(Mar. 1965). (In Norwegian)

A survey was made of the composition and crystal structure of the binary hydrides of the d- and f-metals. The hydrides are grouped according to the structure of their metal lattice, cubic close packing hexagonal close packing, or body-centered cubic. Proton magnetic resonance studies of three representative systems, La/H, Ti/H, and Ta/H, are discussed in some detail. (auth)

26865 ON THE CONSTITUTION DIAGRAM Ta–Pt BETWEEN 50–100 At. Pct Pt. Bill C. Giessen, Robert H. Kane, and Nicholas J. Grant (Massachusetts Inst. of Tech., Cambridge). Trans. Met. Soc. AIME, 233: 855-64(May 1965).

The platinum-rich section of the Ta–Pt phase diagram was worked out by metallographic and x-ray techniques, using twenty alloys. Solidus temperatures and solid solubilities were determined. Besides the σ phase, four intermediate stoichiometric phases were found: TaPt (high-temperature phase, structure unknown); $TaPt_2$ (orthorhombic, new type); α $TaPt_3$ (orthorhombic, $TiCu_3$ type); and β $TaPt_3$ (monoclinic, new type). $TaPt_2$ and $TaPt_3$ melted congruently; two eutectic, two peritectic, and one eutectoid reactions occurred in the investigated range. (auth)

26866 THE INFLUENCE OF HYDROGEN ON THE TENSILE PROPERTIES OF COLUMBIUM, T. W. Wood and R. D. Daniels (Univ. of Oklahoma, Norman). Trans. Met. Soc. AIME, 233: 898-903(May 1965).

The tensile properties of niobium and Nb–H systems containing up to 455 ppm H were studied as a function of temperature and strain rate. Hydrogen, introduced into niobium at elevated temperatures, using a thermal-equilibrium technique, embrittled niobium most severely at about –77°C. This embrittlement occurred even at hydrogen concentrations of an order of 20 ppm. At higher temperatures, the hydrogen tolerance of niobium increased in relation to the increased solubility of hydrogen in the metal. Below this temperature hydrogen tolerance, as determined by ductility and fracture stress, increased slightly. Strain rate had little effect on the tensile results for cross-head speeds over the range 0.002 to 2.0 in. per min. Strain aging during the tensile test appears to explain the ductility minimum at –77°C. The apparent increase in hydrogen tolerance at lower temperatures was attributed to the low mobility of hydrogen. Experiments were performed in which samples were prestrained in tension at room temperature and tested to failure at –196°C. Results suggested that hydrogen segregation to preformed crack nuclei can cause subsequent embrittlement even at temperatures where hydrogen mobility is too low to cause embrittlement in a normal tensile test. (auth)

26867 STRUCTURE OF DRAWN AND ANNEALED TUNGSTEN WIRE. E. S. Meieran and D. A. Thomas (Massachusetts Inst. of Tech., Cambridge). Trans. Met. Soc. AIME, 233: 937-43(May 1965).

Tungsten wires were examined by transmission electron microscopy after drawing and after high-temperature annealing. Drawn wire consists of highly elongated grains called fibers, whose long axis is parallel to [110]. Each fiber is ribbon-shaped, with the wide dimension of the ribbon parallel to (001) and the narrow dimension parallel to $(1\bar{1}0)$. Furthermore, most fibers are bent about [110] and twisted along their length. The fibers are divided into cells, which in some cases contain a platelet substructure lying on $\{110\}$ planes. The misorientations of these platelets accumulate to allow the macroscopic twist of the fibers. During annealing, several competing reactions occur, starting at different temperatures and progressing at different rates. Among these processes are fiber-boundary migration, polygonization, dislocation rearrangement, and possibly impurity segregation. The fiber-boundary migration accompanied by the formation of transverse boundaries during polygonization led to an equiaxed grain structure although recrystallization did not occur. There was a relationship between the flow stress of the wires and their average subgrain width in the form $\sigma_y = \sigma_0 + k_y d^{-\frac{1}{2}}$. Also, there appeared to be a relationship between wire ductility and the formation of transverse boundaries during annealing at about 800°C. (auth)

26868 HARDNESS ANISOTROPY AND SLIP IN WC CRYSTALS. David N. French and David A. Thomas (Ingersoll-Rand Co., Bedminster, N. J.). Trans. Met. Soc. AIME, 233: 950-2(May 1965).

The hardness of WC crystals was measured with the Knoop indenter at loads of 100 and 500 g on the (0001) and $(10\bar{1}0)$ planes. The hardness as measured on the basal plane was 2400 kg/mm² and showed little anisotropy. The hardness on the prism plane, however showed a marked orientation dependence, with a low value of 1000 kg/mm² when the long axis of the Knoop indenter was oriented parallel to the c axis and a high value of 2400 kg/mm² when the indenter was perpendicular to the c axis. Slip lines were observed surrounding the microhardness indentations and they showed slip on $\{10\bar{1}0\}$ planes, probably in [0001] and $\langle 11\bar{2}0\rangle$ directions. This slip behavior can be explained by the crystal structure of WC, which is simple hexagonal with a c/a ratio of 0.976. The hardness anisotropy can be explained by [0001] $\{10\bar{1}0\}$ and $\langle 11\bar{2}0\rangle$ $\{10\bar{1}0\}$ slip and the resolved shear-stress analysis of Daniels and Dunn. (auth)

26869 PREFERRED ORIENTATIONS IN SWAGED AND DRAWN TUNGSTEN WIRE. S. Leber (General Electric Co., Cleveland). Trans. Met. Soc. AIME, 233: 953-9(May 1965).

Pole figures and pole distributions were used for quantitative determination of preferred orientations in swaged tungsten rods and the effect of subsequent wire drawing on the texture. In the swaged rod, the preferred orientation could best be described as a pseudo (111-112)[$\bar{1}$10] cylindrical texture. A secondary component was assigned the indices (110)[001]. Further reduction by swaging retained these cylindrical textures. Wire drawing caused lattice rotations about the wire axis, converting the cylindrical texture into a normal fiber texture. The conversion was initiated and proceeded most rapidly in the center of the wire. The (110) [001] component was converted into a $\langle 110\rangle$ fiber texture by wire drawing. The effective rotations were about axes contained in the transverse plane. (auth)

26870 MICROSTRUCTURES OF LIQUID-PHASE SINTERED BERYLLIUM ALLOYS. C. Y. Ang, E. R. Helderman, and C. C. Nealey (Autonetics, Anaheim, Calif.). Trans. Met. Soc. AIME, 233: 975-83(May 1965).

Beryllium-base alloys were successfully prepared by the liquid-phase sintering technique. Depending on the composition and amount of the intended liquid phase, microstructures either single-phase or duplex in feature with randomly oriented grains were obtained. Qualitative and semiqualitative determination of distribution of alloying elements and microsegregations in some experimental alloys were made by electron-microprobe analysis in conjunction with microhardness testing and standard metallography. Tensile tests revealed that some compositions possess attractive elastic properties with Young's moduli greater than 40×10^6 psi. (auth)

26871 A FRACTOGRAPHIC STUDY OF A THORIATED TUNGSTEN–RHENIUM ALLOY. A. Gilbert, J. L. Ratliff, and W. R. Warke (Battelle Memorial Inst., Columbus, Ohio). Trans. Am. Soc. Metals, 58: 142-9(June 1965).

Electron replica fractography and optical metallography were employed to study the fracture mode of a W–5Re–2.2% ThO_2 alloy sheet, which showed ductility in tension at 0°C. The ThO_2 was found to be deformed into platelets approximately 1000 A thick. It is postulated that during fabrication the platelets give rise to internal cracks lying parallel to the plane of the sheet. During testing these act to blunt and arrest cracks propagating across the specimen, which would normally cause failure. Electron transmission studies on two thoria platelets showed their cleavage plane to be $\{111\}$. (auth)

26872 INFLUENCE OF PLATINUM METALS ON THE MECHANICAL PROPERTIES AND ELECTRICAL CONDUCTIVITY OF TITANIUM–NIOBIUM ALLOYS. Ulrich Zwicker (Forschungsinstitut fur Edelmetalle und Metallchemie, Schwabisch-Gmund, Ger.). Z. Metallk., 56: 222-8 (Apr. 1965). (In German)

Investigations on the influence of replacing niobium in titanium-niobium alloys by metals of the platinum-group showed that the anomalies of the electrical resistivity, which occur in the binary alloys, were also found in the ternary alloys. The number of valence electrons per atom was varied from 4.20 with the metals of the VIII a group of the periodic table to 4.25 with the metals of the VIII c group. Alloys with metals of the VIII a and VIII b group, which were workable (with additions of rhodium, osmium, and iridium) correspond in the as-quenched condition as well as in the cold-worked condition to the analogous binary alloy if this alloy was quenched with a higher quenching rate or they corresponded to an alloy with a higher concentration of valence electrons at the same quenching rate. The workable alloy of the VIII c group (with addition of platinum) corresponded a binary alloy with a smaller amount of valence electrons. The transition temperature increased with increasing valence electron concentration, but was lower than the transition temperature of the corresponding binary alloys. On the transition from the 4th to the 5th period in the VIII a group the transition temperature became lower, it was unchanged in the VIII b group, and raised in the VIII c group. (auth)

26873 URANIUM ALLOYS. Gerard Slattery and John Pardoe (to United Kingdom Atomic Energy Authority). British Patent 984,489. Feb. 24, 1965. Filed Feb. 19, 1963.

Uranium alloys having the following compositions yield a fine grain structure on casting and are substantially free from preferred orientation: (1) 0.125–1.0 at. % Mo, 0.125–1.0 at. % Nb, and 0.5–2.0 at. % Al and (2) 0.125–1.0 at. % Mo, 0.125–1.0 at. % Nb, and 0.125–1.0 at. % Cr, the balance in each case being U and incidental impurities. The alloys are prepared by placing Mg-reduced U billets in a graphite crucible, adding Mo, Nb, and Cr in the form of a 3% or 6% master alloy with U and Al in the form of pure metal, melting at 1550°C under vacuum, casting in alumina-sprayed graphite molds, and annealing at 500–600°C. (A.G.W.)

26874 IMPROVEMENTS IN OR RELATING TO URANIUM ALLOYS. David John Marsh (to United Kingdom Atomic Energy Authority). British Patent 984,846. Mar. 3, 1965. Filed Feb. 11, 1963.

A uranium alloy containing 0.1–0.6 at. % Cr and 0.1–1.2 at. % Nb, the balance being U and incidental impurities, is amenable to grain refinement by heating to 775–900°C followed by continuous cooling at a rate of 100–250°C/min. Alloys having Nb and Cr contents in the upper parts of the above ranges possess in the as-cast condition a sufficiently fine grain size for use in low temperature positions in a nuclear reactor. (A.G.W.)

26875 URANIUM ALLOYS. Gerard Slattery and Michael Melrose Haberlin (to United Kingdom Atomic Energy Authority). British Patent 984,847. Mar. 3, 1965. Filed Feb. 19, 1963.

A uranium alloy containing 0.1–0.75 at. % Mo and 0.1–0.45 at. % Cr, the balance being U and incidental impurities, is amenable to grain refinement by heating to 700–900°C followed by continuous cooling at a rate of 100–250°C/min. Alloys containing Mo and Cr in the upper parts of the above ranges can be grain refined by holding at 710–730°C for 15–30 min, transferring rapidly to a soaking bath at 540–560°C, and holding in the soaking bath for 15–30 min. Alloys so treated are suitable for use as reactor fuels. (A.G.W.)

Radiation Effects

See also CHEMISTRY — Radiation Chemistry.

26876 (ANL-6750) IRRADIATIONS OF U–20Pu–10Fs ALLOY FUEL RODS. W. N. Beck, J. H. Kittel, and R. J. Fousek (Argonne National Lab., Ill.). Feb. 1965. Contract W-31-109-eng-38. 32p. Dep.; $2.00(cy), 1(mn) CFSTI.

Instrumented capsule irradiations were performed with uranium-20 wt % plutonium-10 wt % fissium compositions sodium bonded to various high-temperature jacketing alloys. The specimens were EBR-II-diameter fuel rods that had been reduced to a 51-mm fuel length. The jacketing materials tested were: niobium, Nb-1 wt % Zr alloy, Nb-33 wt %–Ta-1 wt % Zr alloy, Nb-4 wt % V alloy, vanadium, molybdenum, Ta-0.1 wt % W alloy, Inconel-X, Type 304 stainless steel, and Hastelloy-X. A total of 78 specimens was irradiated over a temperature range of 420 to 900°C and burnups of 1.2 to 4.2 at. % heavy metal. Other specimens presently under irradiation have exceeded burnups of 7.2 at. % without indication of failure. It was found that rupture strength of the jacketing material is not the only criterion of the restraint characteristics of the jacket during irradiation. The optimum relationship appears to be a jacket that retains a high rupture strength with a high degree of ductility. The lifetime of the fuel specimens before failure occurred was also significantly extended by increasing the void space within the jacket. (auth)

26877 (ARL-65-60) ELECTRON RADIATION DAMAGE IN ZnSe AT LOW TEMPERATURE. B. A. Kulp and R. M. Detweiler (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Mar. 1965. 27p. CFSTI.

A threshold for radiation damage in ZnSe is reported at 240 kev under electron bombardment. Fluorescence bands at 5460 and 5850 Å are produced. The damage causing these fluorescence bands anneals completely in a single stage at about 130°K. At 10°K, somewhat different fluorescence bands are produced. Following heat treatment above 90°K, the fluorescence spectrum produced by the 10°K bombardment anneals into that produced by the 80°K bombardment. This indicates that at least one and possibly more of the fluorescence centers observed following bombardment at 80°K is a "complex" center. That is, it is composed of a defect of Zn or Se in association with a foreign impurity. A second threshold for radiation damage in ZnSe was observed while bombarding at 10°K. This threshold is at 190 kev and is believed to be that for displacement of the Zn atom from the lattice. The 240 kev threshold is therefore associated with displacement of the selenium atom. The displacement energies are 7.6 ev for the zinc and 8.2 ev for the selenium atom. These values are compared to 7.3 ev and 8.7 ev for the cadmium atom and sulfur atom previously measured in CdS. (auth)

26878 (BAW-3376-2) IRRADIATION PERFORMANCE OF THORIA–URANIA FUEL MATERIALS. Quarterly Technical Report No. 2, October–December 1964. (Babcock and Wilcox Co., Lynchburg, Va.). Contract AT(30-1)-3376. 51p. Dep.; $3.00(cy), 1(mn) CFSTI.

Progress is reported in the measurements of gas permeability, sorbed gas release, unirradiated thermal conductivity, irradiated thermal conductivity, in-pile fission gas release, and static gas release of thoria–urania fuels. (W.L.G.)

26879 (BNWL-24) PHYSICAL PROPERTY CHANGES IN THORIUM POSTIRRADIATION ANNEALED TO 950°C. R. D. Leggett (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1965. Contract AT(45-1)-1830. 20p. Dep.; $1.00(cy), 1(mn) CFSTI.

Tensile specimens of two lots of thorium were irradiated to ~0.06 at. % burnup, and tested at 590 and 815°C, respectively. The strength of all specimens was reduced at the elevated temperature, but the differences in yield and ultimate strengths revealed that a large amount of work hardenability remained in the unirradiated specimens. The irradiation doubled the yield strength, greatly reduced the strain-hardenability, and significantly reduced the percent total elongation. In the irradiated specimens extensive reduction in area occurred at 590°C, whereas little occurred at 815°C. This may be due to segregation of fission products to the grain boundaries at 815°C. The effects were much smaller than have been observed with uranium and are attributed to the isotropic crystal structure of thorium. The grip ends of broken tensile specimens from this and a

previous study were examined metallographically before and after several postirradiation anneals, and hardness and density measurements were made. The only metallographic evidence of damage in the as-irradiated state was the severe fragmentation of oxide inclusions in a very high burnup (~1 at. %) specimen. Irradiation caused a pronounced increase in hardness, much of which was recoverable during annealing. Very little density change occurred in specimens with burnups as high as 0.18 at. % upon annealing up to 950°C for 100 hr, and even a high burnup (~1 at. %) specimen swelled only about 20% with this treatment. Severe grain boundary porosity existed in the latter specimen, and very tiny (<0.1μ) pores existed throughout the matrix. It is suggested that the high melting point of thorium results in its remarkable swelling resistance rather than its isotropic crystal structure. A secondary attribute, stemming of course from its isotropic crystal structure, is its excellent mechanical properties after irradiation. (auth)

26880 (EUR-2188.e) EFFECTS OF α-PARTICLE IRRADIATION ON THE X-RAY INTENSITIES DIFFRACTED BY GERMANIUM CRYSTALS. R. Colella and A. Merlini (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1965. 12p. (CONF-640705-1) Dep.(mn).

From Conference on Radiation Effects, Paris.

On the basis of the dynamical theory of x-ray diffraction, the integrated intensities reflected in the Bragg case by a perfect crystal are, in favorable cases, many times smaller than those reflected by a mosaic crystal. The present investigation was undertaken with the purpose of establishing whether the lattice defects introduced in an initially perfect crystal by energetic particle irradiation affect the values of the x-ray integrated intensities. Nearly perfect germanium single crystals, n-type, with a resistivity of 0.5 Ω-cm, cut with a (111) plane parallel to the surface, were irradiated at liquid nitrogen temperature with the 5.3 Mev alphas of a 0.1-Curie ^{210}Po source. Maximum irradiation doses were of the order of 10^{18} alphas/cm^2. CuKα radiation reflected by a curved quartz monochromator was used through all the experiments. The integrated intensity of the (333) reflection in the Bragg case increased with irradiation time up to a value 80% higher than the original value before irradiation, although no broadening of the diffracted line was detected by a photographic technique. On the other hand, the intensity of the (111) reflection did not increase appreciably. Also, no decrease in intensity was observed in anomalous transmission at room temperature on the (220) planes perpendicular to the surface. The difference in the behavior of the (111) and (333) reflections might be due to the extension lengths and to the intervals of total reflection which are different from the two sets of reflection. The density of the displaced atoms as a function of the penetration depth of the α-particles was calculated by using the Rutherford and hard-sphere scattering laws and the model of Seitz and Harrison. There is no direct correlation between the concentration of the total number of displaced atoms and the observed increase in diffracted intensities. (auth)

26881 (EURAEC-1333) SWELLING OF URANIUM. Period Covered: April 1, 1962–September 30, 1963. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Work Performed under United States–Euratom Joint Research and Development Program. Contract 087-62-4 RDB. 44p. (EUR-2310). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Efforts during the period were devoted to electron microscope studies of the dislocation structure in non-irradiated α-U foils and thermal neutron damage in α-U. The method of preparing U foils of about 20-μ thickness is described. Foils were deformed by cold work and partially annealed at 550 to 650°C; others were irradiated in the BR-1 reactor at –195°C and 80°C. At the lower temperature, irradiations were carried out to a dose of 0.8×10^{18} thermal neutrons/cm^2 (1.5×10^{17} fissions/cm^3); at the higher one, three different doses were given: 5×10^{15}, 2.5×10^{16} and 10^{17} thermal neutrons/cm^2 (0.95×10^{15}, 4.75×10^{15} and 1.9×10^{16} fissions/cm^3). To obtain specimens transparent to electrons, the foils were thinned by electropolishing. The dissociation of dislocations into partials in α-U is shown by extended and contracted nodes in twist boundaries. A theoretical consideration of the structure of α-U is included. It is pointed out that dissociation into partials is geometrically possible for dislocations in the c-plane. The experimental data lends support to the idea that the formation of dislocation loops during irradiation may be responsible for the observed growth phenomenon of α-U. (J.R.D.)

26882 (EURAEC-1343) THE EFFECT OF RADIATION ON THE DUCTILE-BRITTLE TRANSITION IN PRESSURE VESSEL STEELS. Sixteenth Quarterly Report, October 1, 1964–January 31, 1965. E. Anderson, D. G. Brandon, G. T. Hahn, D. L. King, D. Langheinrich, M. Malone, and J. Spreadborough (Battelle Memorial Inst., Geneva (Switzerland)). Feb. 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract 095-62-12 RDS. 35p. (EUR-2319). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Dislocation arrangements in Armco iron were revealed by etch-pitting with Fry's reagent. Two groups of specimens–one group annealed above the transformation range, and the other below it–were examined before and after deformation at room temperature and at –196°C. Details of the initial substructure, the identity of active sources, the character of slip at the two temperatures, and some features of the twinning process at –196°C are described. Preliminary experiments on the field-ion microscopy of steels are reported. Neon images of pure iron, Armco iron and a Fe-1.6 wt % Si alloy were produced and recorded successfully. (auth)

26883 (LA-3285) IRRADIATION DAMAGE TO CERAMICS, METALLIC-CERAMIC BONDS, AND BRAZING ALLOYS. Alton J. Patrick (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Jan. 1965. Contract W-7405-eng-36. 45p. Dep.; $3.00(cy), 2(mn) CFSTI.

Irradiation damage to ceramics, metallic-ceramic bonds, and brazing alloys is described for a temperature range of 700 to 970°K. Data are presented for an accumulated thermal neutron flux from 1.36×10^{21} to 2.77×10^{21} and for an accumulated fast neutron flux (>1 Mev) from 1.5×10^{20} to 3.17×10^{21}. These experiments were carried out in the MTR at Arco, Idaho, and in the LAMPRE reactor at Los Alamos Scientific Laboratory. In this temperature range the samples tested of BeO, MgO, magnesia spinel, and Y_2O_3 were found to be unsatisfactory. 97.5% Al_2O_3 (Al-300), 98% Al_2O_3 + 2% Y_2O_3 (Al-13), and 99.5% Al_2O_3 + 0.5% Y_2O_3 (Al-14) were found to be the most resistive to irradiation damage. The electrical resistivity of the ceramics tested was lower after irradiation. (auth)

26884 (NIJS-R-442) EFFECT OF IONIZING RADIATION ON THE FERROELECTRIC CURIE TEMPERATURE OF $NaH_3(SeO_3)_2$. R. Blinc, P. Cevc, and D. Vovk (Nuklearni Institut "Jozef Stefan," Ljubljana (Yugoslavia)). Nov. 1964. 3p. Dep.(mn).

The temperature dependence of the dielectric losses was measured on $NaH_3(SeO_3)_2$ samples subjected to various stages of γ-ray damage. The ferroelectric Curie temperature was found to be a non-linear function of the γ-ray dose, tending toward saturation at doses >60 MRep. The effects of irradiation on the ferroelectric hysteresis loops were also studied. (D.L.C.)

26885 (NIRL-R-83) THERMAL RADIATION ABSORPTION OF METALS AND LAYERED INSULATIONS AT 80°K. B. Colyer (National Inst. for Research in Nuclear Science, Chilton (England). Rutherford High Energy Lab.). Jan. 1965. 16p. Dep.(mn); $0.50(BIS), 2s. 6d. (HMSO).

Values of thermal radiation absorption at 80°K for constructional metals (with various surface treatments) and layered insulations were measured. The experimental method and the method of calculation of results are described. Some suggestions are made for the effective insulation of laboratory equipment. (auth)

26886 EFFECT OF IMPURITIES ON THE MAGNETIC COUPLING HYSTERESIS EFFECT OF IRON IRRADIATED WITH FAST NEUTRONS. Pierre Vigier and Pierre Moser

(Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., 260: 2443-6(Mar. 1, 1965). (In French)

A study, by the magnetic coupling hysteresis effect, of impure iron irradiated with fast neutrons at 77°K shows various modifications of the band characteristics. The existence of particular phenomena connected with nickel is noted. (tr-auth)

26887 EFFECTS OF RADIOACTIVE RADIATION ON PLASTICS. R. Krauss and H. Bannmann. Elektronik, 13: 363-4(Dec. 1964). (In German)

A brief review is given of the types of radiation, units for absorbed energy, and the basic effects that can be produced by radiation. The effects of radiation on various organic and inorganic materials are tabulated. The tables show that epoxy possesses the highest radiation stability of all classes. (J.S.R.)

26888 IRRADIATION STUDIES OF LEAKPROOF (COATED PARTICLE) FUELS FOR THE DRAGON REACTOR. Gilles Hauser. Energie Nucl., 7: 100-12(Mar.-Apr. 1965). (In French)

Irradiation experiments were made on coated-particle fuels. A great number of the particle parameters were varied for the purpose of this study. Kernels contained $(Th,U)C_2$ or (Zr,U)C solid solutions of variable compositions. Single or multi-layer pyrocarbon coatings were used, with or without a layer of silicon carbide. Irradiation conditions (temperature, burnup) were also varied in several facilities either sealed or purged. Results showed that it is possible to get very low fission gas releases ($R/B = 10^{-6}$) at temperatures up to 1600°C. As far as solid fission products are concerned, the best results were observed when using an intermediate layer of silicon carbide within the coating. No influence of the burnup was observed on the fuel behavior. (auth)

26889 DAMAGE CAUSED BY FISSION FRAGMENTS IN EVAPORATED METALLIC FILMS. Takayoshi Nagasaki and Kensuke Shiraishi (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 10: No. 7, 56-9(July 1964). (In Japanese)

When a substance containing uranium is irradiated by neutrons, the uranium fissions, and two fission fragments with high energy from which about twenty electrons are removed are produced. These fission fragments lose their energy by colliding with other atoms and exciting other electrons. Along the path of this fragment is formed a region of disordered or highly heated atoms. This region showing the range of fission fragments is observed directly in evaporated thin film specimens, using an electron microscope. The materials tested were UO_2, Al dispersed with UAl_4, U-Mo, etc. (NSA of Japan)

26890 FRICTIONAL PROPERTIES OF HIGH POLYMERS IRRADIATED BY γ-RAYS. Kiyoshi Matsubara and Makoto Watanabe (Government Mechanical Lab., Japan). Genshiryoku Kogyo, 10: No. 9, 49-55(Sept. 1964). (In Japanese)

Nylons (6, 66), polyethylenes (low-density, high-density), and polyfluoroethylenes (trifluoro-, tetrafluoro-) were irradiated by γ rays from Co-60 (10^4 C) at room temperature and at dose rates of 3.5×10^4 or 8.1×10^5 R/hr in vacuum 10^{-2} mmHg. The friction coefficients of the irradiated polymers for steel (0.15% carbon) were investigated by a method in which the sliding frictional force of the sample ring to the rotating steel ring was measured at a sliding velocity of 0.01 cm/sec. By the 10-R irradiation, the friction coefficients of nylons and high-density polyethylene were increased about two- and four-fold, respectively; but for low-density polyethylene and polyfluoroethylene there was observed no remarkable change. The relation between the friction coefficient and the load $\mu \propto W^{-\alpha}$; μ the friction coefficient, W the load, and α the index) was examined. The index α was decreased for high-density polyethylene by irradiation, becoming about zero between 1×10^8 R and 3×10^8 R; it then increased to that of the unirradiated with increasing dosage. In polytetrafluoroethylene, the index decreased monotonically with irradiation. Other properties such as rigidity, shear stress, and stiffness were decreased by irradiation in nylons and high-density polyethylene, but in polytetrafluoroethylene and low-density polyethylene they were increased slightly. The temperature dependence of the friction coefficient was investigated for high-density polyethylene. The critical temperature at which the friction coefficient begins to decrease with (increasing) temperature was raised a little by irradiation. However, at above 150°C, the difference in the friction coefficient was small between the unirradiated and irradiated samples. (NSA of Japan)

26891 EFFECTS OF GAMMA IRRADIATION IN SEMI-RIGID EPOXIES. F. F. Stucki and D. M. Newell (Lockheed Missiles and Space Co., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 2, 37-41(Apr. 1965).

An investigation of radioinduced stress changes in two types of epoxies is discussed. A semirigid 3M-241 type of Scotchcast material, which has low intrinsic internal stress, was irradiated. The increase in stresses due to radiation is twofold. First, the material seems to cure out completely. Further irradiation led to a linear pressure increase, which was reversible once the material was removed from the gamma source. The very rigid Epocast type H2E-011 material, when completely cured, had high intrinsic stresses of 30,000 psi. When irradiated for an extensive period, the material changed color from a light yellow to brown; and the internal stresses were reduced threefold. After the sample was removed, it regained the original high internal stress condition after two months on the shelf. (auth)

26892 GAMMA IRRADIATION OF SILICON. III. LEVELS IN p-TYPE MATERIAL. E. Sonder and L. C. Templeton (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 36: 1811-15(June 1965).

Gamma irradiation (^{60}Co) of p-type silicon produces donors in the lower half of the forbidden gap. From the temperature dependence of the electric properties, a level 0.35 ev above the valence band was located for the case of silicon pulled from silica crucibles. For the case of float-zone silicon, two levels 0.21 and 0.28 ev above the valence band were found. The 0.35-ev level is introduced at the rate of 10^{-4} net donors/cm^3 per photons/cm^2. The introduction rate for the 0.21-ev level is lower than that for the 0.35 level, and that for the 0.27-ev level is so low that it was difficult to measure. (auth)

26893 RELATIONSHIP BETWEEN PREFERRED ORIENTATION, THERMAL EXPANSION, AND RADIATION-INDUCED LENGTH CHANGES IN GRAPHITE. R. J. Price and J. C. Bokros (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Appl. Phys., 36: 1897-1906 (June 1965). (GA-5571)

Expressions may be derived for the thermal expansion coefficient of polycrystalline graphite in terms of the single-crystal coefficients and the preferred orientation of the sample. Thermal expansion and preferred orientation measurements were performed on pyrolytic, molded, hot-worked, extruded-rod, and extruded-tube graphites in order to test the validity of this model. They showed that such expressions adequately represent the behavior of several different graphites over a range of temperatures, provided that the "accommodation" of a part of the c-direction crystallite expansion by microcracks is taken into account. The amount of c-direction accommodation is a function of preferred orientation and the direction of measurement. It is small for the principal c direction in a highly oriented body and large for a random aggregate of crystallites and is probably controlled by the number of microcracks which form on cooling from the graphitization temperature. A model similar to that used for thermal expansion may be used to express the irradiation-induced dimensional changes in polycrystalline graphite in terms of the preferred orientation of the sample, a contraction in the crystallite a direction, and an expansion in the crystallite c direction which is partially accommodated by microcracks. The model was found to be in reasonable agreement

with published irradiation data for a number of graphites. (auth)

26894 ELECTRON IRRADIATION OF Al–1.7 at. % Cu IN THE REVERTED CONDITION. H. Herman (Univ. of Pennsylvania, Philadelphia), J. W. Kauffman, and M. E. Fine. J. Appl. Phys., 36: 1976-8(June 1965).

Electron irradiation with doses of 10^{18} electrons/cm^2 at 1.5 Mev of an Al–1.7 at. % Cu alloy in the reverted condition does not result in enhanced nucleation of Guinier–Preston zones. An incubation time is still observed on reaging at 30°C, after irradiation at the temperature of liquid nitrogen. The difference in nucleation after quenching from 500°C and after reversion at 200°C is thus apparently not due to the difference in vacancy concentration alone. Irradiation, however, does result in an increased degree of decomposition of the solid solution, and this demonstrates the important role played by vacancies in the formation of zones. (auth)

26895 PRODUCTION OF LARGE ELECTRIC FIELDS IN DIELECTRICS BY ELECTRON INJECTION. H. Lackner, I. Kohlberg, and S. V. Nablo (Ion Physics Corp., Burlington, Mass.). J. Appl. Phys., 36: 2064-5(June 1965).

Targets of Lucite and polystyrene were irradiated by a 1.5-Mev electron beam until breakdown occurred. Framing camera films of these events show a steadily decreasing thickness of the fluorescing region until breakdown, at which time the thickness returns to its original value. This is interpreted as a decrease in electron range with charge buildup, with electric field strengths in excess of 6.3 Mv/cm inferred for one of the cases (Lucite) studied. (auth)

26896 TWO NEW PARAMAGNETIC CENTERS IN IRRADIATED, OXYGEN-DOPED GERMANIUM. John A. Baldwin, Jr. (Sandia Lab., Albuquerque, N. Mex.). J. Appl. Phys., 36: 2079(June 1965).

A crystal of germanium containing approximately 10^{17} dispersed (interstitial) oxygen atoms per cm^3 was irradiated to a total flux of 10^{18} 2-Mev electrons per cm^2 inside an insulated tube through which cold nitrogen gas was passed. After irradiation the crystal was examined in a Varian V4500 EPR spectrometer operating at ~9.7 Bc with the sample at 1.9°K. The resonances observed are discussed. (C.E.S.)

26897 PRODUCTION OF ALUMINUM HYDRIDE BY HYDROGEN-ION BOMBARDMENT. M. Appel and J. P. Frankel (Univ. of California, Los Angeles). J. Chem. Phys., 42: 3984-8(June 1, 1965).

An ultrapure aluminum target specimen was bombarded with 12.5-Mev deuterons for 300 $\mu a \cdot hr$. The specimen was sufficiently thick so that all the hydrogen was trapped within it. At no time did the temperature exceed 300°F. X-ray diffraction studies of the specimen indicated the formation of a new phase with the hexagonal structure predicted for aluminum hydride and d spacings, which coincided with those given for aluminum hydride in the literature. Least-squares analysis of 21 diffraction peaks showed a hexagonal structure with $c/a = 1.57 \pm 0.05$, $c = 4.55 \pm 0.08$ Å, and $a = 2.90 \pm 0.05$ Å. (auth)

26898 THE EFFECT OF HEATING IRRADIATED URANIUM AT TEMPERATURES ABOVE 800°C. G. L. Reynolds (Central Electricity Generating Board, Berkeley, Glos., Eng.). J. Nucl. Mater., 16: 1-6(May 1965).

The effects of time and temperature on the size and distribution of fission gas bubbles in uranium were determined. Prior to bubble overlap, a large variation of swelling with temperature was found, which is ascribed to a fission gas re-solution mechanism whereby the larger bubbles can grow. In this range there was no microstructural evidence of bubble sweeping, and coalescence only occurred when bubbles became sufficiently close. An approximate activation energy of 3.7 ev was derived, which was considered to be the sum of the heat of solution of the fission gas and its activation energy of diffusion. The variation of swelling with time at constant temperature indicated the relative importance of surface diffusion processes, while bubbles were still small and of self-diffusion of the matrix atoms in the later stages when bubbles were large enough to overlap. (auth)

26899 THE EFFECT OF PRE-IRRADIATION HEAT TREATMENT AND A BRIEF POSTIRRADIATION BETA ANNEAL ON SWELLING OF ALPHA URANIUM. B. A. Loomis and S. B. Gerber (Argonne National Lab., Ill.). J. Nucl. Mater., 16: 49-53(May 1965).

The effects of pre-irradiation heat treatment and of a brief postirradiation anneal at a temperature in the beta range on the swelling of irradiated uranium during annealing at 620°C are described. The experimental data showed that irradiated specimens deformed and recrystallized before irradiation decreased in density on annealing at 620°C substantially more than irradiated specimens quenched from a beta temperature before irradiation for burnups greater than 0.04%. The data also showed that extensive swelling of irradiated uranium on annealing at 620°C can be minimized by a prior brief anneal of the irradiated uranium in the beta phase. The interpretation of these results is supported with photomicrographs of the swelled specimens. (auth)

26900 IRRADIATION OF FUEL ELEMENTS AT HIGH TEMPERATURE. C. Allain, J. Lehmann, G. Colombe, and M. Englander (CEN, Saclay, France). J. Nucl. Mater., 16: 54-8(May 1965). (In French)

To determine the influence of temperature on the volume increase (swelling) of uranium subjected to neutron irradiation, fuel elements of uranium-molybdenum alloy (1 wt % Mo) were irradiated in the EL 3 reactor. The temperature ranged from 260°C (at the external surface of the tube) to 600°C (internal surface of the tube); this last temperature was measured by three thermocouples. One fuel element was examined after a burn-up of about 0.4%. On the cross-section of the tube a "crown" was seen along the central part of the tube thickness. This "crown" contained numerous large cavities. The overall volume increase was about 10%, which was revealed by an external diameter increase of 0.5 mm. This phenomenon is attributed to cavitation appearing at grain boundaries because of internal stresses caused by growth in a temperature range between the recovery temperature and the recrystallization temperature. (auth)

26901 THE PRODUCTION OF HYDROGEN AND HELIUM IN METALS DURING REACTOR IRRADIATION. H. Alter and C. E. Weber (Atomics International, Canoga Park, Calif.). J. Nucl. Mater., 16: 68-73(May 1965).

Available data on (n,p) and (n,α) reactions were used to calculate the buildup of hydrogen and helium in metals and alloys, and also in nonmetals. A fission spectrum fast flux of 10^{16} uv was chosen as representative of a reasonable upper limit for future fast reactors and a time period of two years was arbitrarily used. Results are presented in tables. (M.C.G.)

26902 IRRADIATION DOSE AND XENON DIFFUSION IN URANIUM DIOXIDE. G. Frigerio and T. Gerevini (FIAT, Turin). J. Nucl. Mater., 16: 76-8(May 1965).

A decrease in the apparent diffusion coefficient of xenon with increasing radiation dose was observed at annealing temperatures of 1330 and 1565°C, whereas the diffusion values measured at 1800°C did not show any significant variation with radiation dose. The trapping of xenon on vacancy clusters is discussed. (M.C.G.)

26903 HIGH-TEMPERATURE GAS RELEASE IN KRYPTON-BOMBARDED PLATINUM DUE TO THE FORMATION AND MOTION OF BUBBLES. Erich Ruedl and Roger Kelly (Euratom, Ispra, Italy). J. Nucl. Mater., 16: 89-102(June 1965).

To obtain information of the role played by bubbles in inert-gas diffusion, gas-release measurements in krypton-bombarded platinum were correlated with transmission electron microscopy. Release components having temperatures of roughly ambient 500, 500 to 850, and > 850°C are shown to occur in specimens bombarded at each of the energies 0.5, 3, and 9 kev. The parallel microscope work revealed that the dislocation loops formed in the bombardment

are stable at the temperatures of the first release component, though they begin annealing in approximate coincidence with the second component. At higher temperatures (650 to 700°C), spots resembling bubbles and normally free of dislocations and grain boundaries appeared at all three energies. That the spots are really bubbles was implied both by the presence of up to 25% of the original gas at high temperatures and by the qualitative similarity of their distribution to that of the gas. The bubbles can be made to move and escape by pulse-heating or by using a heating stage. It was concluded that the high-temperature release component is consistent with bubble motion by the surface-diffusion mechanism of Greenwood and Speight. That is, the predicted temperatures for bubble release as a function of bubble diameter overlap those observed for the gas release. The value 66 ± 6 kcal/mole was obtained for the activation enthalpy for Kr–Pt. This value is believed to be applicable only at high gas concentrations. (auth)

26904 A NEW DAMAGE FUNCTION FOR PREDICTING THE EFFECT OF REACTOR IRRADIATION ON GRAPHITE IN DIFFERENT NEUTRON SPECTRA. M. W. Thompson and S. B. Wright (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 16: 146-54(June 1965). (AERE-R-4701)

The damage function $\nu(E_2)$ is the number of displaced atoms produced by a recoil atom with energy E_2. The assumptions made in previous derivations were examined and it was concluded that random cascade theories are insensitive to both the displacement model and that the exact nature of the interatomic collision and the Kinchin and Pease function $E_2/2E_d$ is a good approximation. Recent measurements of the displacement energy E_d by Mitchell and Lucas made quantitative calculations possible. Focusing is not expected to effect $\nu(E_2)$ significantly and the question of channeling is left open. Energy lost from the cascade by electron excitation is known to be an important effect, but previous attempts to include it in the theory were crude and based on scanty experimental justification. Measurements were recently made of the energy loss of electrons from C^+ ions in graphite below 1 Mev. These data were incorporated into the theory of the damage function and a function was derived, which can be used to predict the effect of changing the neutron spectrum on the damage rate in graphite. This theory gives a small but significant improvement in the agreement between predicted and observed rates. (auth)

26905 DETERIORATION OF THE PROPERTIES OF VARIOUS VULCANIZED RUBBERS BY GAMMA IRRADIATION. Kogyo Zairyo, 12: No. 9, 86-7(Aug. 1964). (In Japanese)

Eight kinds of vulcanized rubber were irradiated by γ rays and the physical properties were measured by the ASTM methods. The rubbers tested were silicone rubber (I), fluorocarbon rubber (II), NBR (III), natural rubber (IV), CR(V), SBR(VI), IIR(VII), and polyethylene rubber (VIII); the radiation doses used were 5×10^4, 5×10^6, and 1×10^8 R. There were observed no remarkable changes in properties at radiation doses of 5×10^4 and 5×10^6 R for all the rubbers. Large decreases in tensile strength were observed at 1×10^8 R for (I), (IV), (V), and (VII), whereas for (II), (III), and (VI) there were observed little or no changes. The elongations at break decreased considerably for all the rubbers at 1×10^8 R. The shore hardnesses of all the rubbers increased very much at the same dose. The compression sets of (III), (VI) and (VIII) irradiated at 1×10^8 R were nearly equal to those of the unirradiated, while for other rubbers it increased or decreased considerably (the (II) and (VII) were not determined). No change in the specific gravity was observed with the exception of a slight increase for (I). It is concluded that the rubbers suitable as packing materials under gamma irradiation are (III), (VI), and (VIII). (NSA of Japan)

26906 NATURAL IRRADIATION DAMAGE IN IVORY COAST DIAMONDS. H. O. A. Meyer, H. J. Milledge, and E. Nave (University Coll., London). Nature, 206: 392 (Apr. 24, 1965).

Rotation photographs of Ivory Coast diamonds showed weak streaks extending from the Bragg spots on the low-angle (high-spacing) side, the effect being especially marked at high. Laue photographs taken with white + characteristic CuK radiation showed the triangles of spots and streaks typical of Type I diamonds, but showed also thermal diffuse spots that were abnormally intense. Both these effects are indicative of disorder and are characteristic of diamonds that have been heavily irradiated by fast neutrons in an atomic reactor. Rotation photographs of a dark green surface fragment and of a clear white inner fragment showed that the lattice expansion was confined to the green skin. This implies that the coloration of the Ivory Coast diamonds is due to α irradiation, since its penetration was small, though damaging. (P.C.H.)

26907 EFFECTS OF IN-PILE IRRADIATION ON THE CORROSION BEHAVIOR OF METALS. Sun-Chae Maeng and Jong-Jean Kim. New Phys. (Korea), 4: No. 1, 6-16 (1964).

Radiation effects on the corrosion behavior of high purity (99.99%) aluminum and copper were investigated for samples irradiated in the TRIGA Mark II Reactor. The samples were corroded in distilled water during the irradiation. The copper sample lost weight through irradiation. The corroded aluminum gained weight. In the first stage of aluminum corrosion, irradiation accelerated the weight gain a little, but in the second stage, irradiation decelerated the weight increase. In a dilute HCl solution (pH : 1), corroded copper and aluminum showed appreciable weight losses. In the irradiated samples the weight losses were greater than the control samples. Compared with the control samples, the samples that were irradiated previously (by a total integrated flux of $\sim 2 \times 10^{18}$ nvt) and were corroded in a distilled water or in a dilute HCl solution, showed no remarkable differences in corrosion behaviors. The radiation effects on corrosion behaviors of cold worked samples were also examined. (auth)

26908 EFFECT OF ELEVATED-TEMPERATURE IRRADIATION ON HASTELLOY N. W. R. Martin and J. R. Weir (Oak Ridge National Lab., Tenn.). Nucl. Appl., 1: 160-7(Apr. 1965).

The tensile properties of Hastelloy N were determined after irradiation at 700°C to a dose level of 7×10^{20} n/cm^2 (E > 1 Mev) and 9×10^{20} n/cm^2 (thermal). The strength and ductility of the material were determined as functions of deformation temperature from 20 to 900°C. These properties were also examined as functions of strain rate within the limits of 0.002 and 0.2 in./min (0.005 and 0.5 cm/min) for deformation temperatures of 500, 600, 700, and 800°C. The stress-strain relationship was not affected by irradiation at 700°C. Ductility, as measured by the true uniform and fracture strains, was reduced for deformation temperatures of 500°C and above. The loss in ductility resulted in a reduction in the true tensile strength. This loss was more significant at test conditions resulting in intergranular failure, such as low strain rates at elevated temperature. Postirradiation annealing of the irradiated alloy did not result in improved ductility. These data were compatible with the experiments suggesting helium generation from the (n,α) reaction of boron as the cause of low ductility. The low ductility of irradiated alloys in general is described in terms of the present knowledge of intergranular fracture. Means of improving the ductility are discussed. (auth)

26909 BEHAVIOR OF URANIUM SULFIDE FAST-REACTOR-TYPE FUEL SPECIMENS UNDER TRANSIENT HEATING IN TREAT. L. E. Robinson, C. E. Dickerman, R. Carlander, C. August, and C. Mueller (Argonne National Lab., Ill.). Nucl. Appl., 1: 168-75(Apr. 1965).

Transient nuclear heating experiments were carried out on gas-bonded, refractory-metal-clad uranium monosulfide specimens in the Transient Reactor Test Facility. The range of temperatures attained extended to the fuel melting point of 2462°C. Although some fuel slumping was observed, the specimens did not suffer the mechanical damage and fragmentation found for uranium dioxide samples tested earlier. In this respect, the uranium monosulfide behavior was considered to be more satisfactory from the stand-

point of safety. The general behavior of the uranium monosulfide samples was consistent with its material properties. (auth)

26910 RADIATION DAMAGE OF DIAMOND BY 20-kev CARBON IONS. R. L. Hines (Northwestern Univ., Evanston, Ill.). Phys. Rev., 138: A1747-51(June 14, 1965).

Radiation damage in diamond due to bombardment by 20-kev C^+ ions is observed from measurements of the optical reflection and transmission coefficients at wavelengths of 450, 500, 550, 600, and 650 mμ. These measurements are analyzed to obtain the depth, refractive index, and absorption coefficient of the bombarded layer. The damage is found to be specimen-dependent with a typical increase in refractive index of 0.10 and an absorption coefficient of 0.065 per vacuum wavelength, for a bombardment of 9.4×10^{14} ions/cm^2. For a given specimen, the damage shows an initial saturation at 1.5×10^{14} ions/cm^2 with a subsequent slower increase in damage. The depth of the bombardment layer in all specimens is found to be about 0.056 μ for the 20-kev C^+ ions. The damage is stable at room temperature and anneals gradually as the temperature is increased until complete annealing is obtained at 756°C. Analysis of the isochronal annealing curve shows that the activation-energy-of-motion spectrum for the bombardment-induced imperfections contains two major peaks which are calculated to be at 1.0 and 2.7 ev using a frequency factor of 10^{12}. (auth)

26911 IONIZATION PRODUCED BY ENERGETIC SILICON ATOMS WITHIN A SILICON LATTICE. A. R. Sattler (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 138: A1815-21(June 14, 1965).

The energy dependence of the ionization produced in silicon by energetic silicon atoms was measured. Silicon solid-state detectors served simultaneously as crystalline silicon sample, neutron target, and ionization detector. The spectrum of ionization produced by prompt Si recoil atoms energized by monoenergetic neutron bombardment was observed in a pulse-height analyzer, and the edge of the spectrum was identified with the ionization of Si recoil atoms having the calculated maximum recoil energy. The electron-hole pair production of Si recoils was measured in this manner from 21.2 kev to 3.14 Mev, using monoenergetic neutrons from 159 kev to 23.6 Mev. In this energy range the ionization produced by a Si recoil relative to that of an electron of the same energy varied from ~0.3 to ~0.95. At very low Si recoil energies most of the energy goes into atomic collisions; at high recoil energies the ionization produced by a Si recoil approaches that of an electron of the same energy. The corresponding partition of energy between electronic processes and atomic processes for an energetic silicon atom in a silicon lattice agrees favorably with predictions of the theory of Lindhard et al. (auth)

26912 FISSION PRODUCT GASES FROM URANIUM DIOXIDE IRRADIATED WITH THERMAL NEUTRON. Kaoru Taniguchi (Hitachi Ltd., Tokyo) and Jun Okano. Shitsuryo Bunseki, 12: 163-4(Dec. 1964).

Uranium dioxide was irradiated with thermal neutrons in the Hitachi training reactor. Fission-product gases, Kr and Xe, were determined by the isotope dilution method with a mass spectrometer. Details of the procedure are described. Mass spectra of the rare gas fission products are shown and it was found that the ratio of the detected amount of each isotope agreed well with the ratio of their fission yields. (auth)

METEOROLOGY

See *also* GEOLOGY AND MINERALOGY — Site Survey and Selection.

26913 (AD-607980) REPORT ON PROJECT SPRINGFIELD. E. F. Danielsen (Isotopes, Inc., Westwood, N. J.). July 15, 1964. Contract DA-49-146-XZ-079. 113p. (DASA-1517). $4.00(CFSTI).

The theory and confirmation of a stratospheric-tropospheric exchange which accompanies a folding of the tropopause are reported. Air from the lower part of the cyclonic stratosphere is extruded to form a thin inclined layer in the troposphere. The Springfield data prove that the extruded tropospheric layers contain radioactivity concentrations typical of the stratosphere. Concentrations exceeding the tropospheric by one or two orders of magnitude were measured aboard WB-50 and RB-57 aircraft on specially vectored flight paths. The sharp change in concentrations at the boundaries also confirms that the folding process is predominantly laminar, so it is appropriate to refer to the exchange as a transport rather than a diffusion process. The agreement between the radioactivity and meteorological measurements is remarkable. Of particular value to the radiochemist and meteorologist is the high correlation between the concentrations of radioactivity and the potential vorticity. Since the latter can be determined from conventional radiosonde data, the three-dimensional distribution of the former can be approximated. Physical processes capable of mixing the radioactivity from the layers to the ground are also discussed, including their probable distribution with respect to the extruded layers. (auth)

PHYSICS

General

Refer also to abstracts 27735 and 27736.

26914 (AD-607386) THE ENERGY OF ELECTRONS IN A GAS IN AN ARBITRARY ELECTRIC FIELD. [PART] I. Paul Molmud (Ramo-Wooldridge Corp., Los Angeles). Mar. 22, 1956. 9p. $1.00(CFSTI).

The average energy of electrons in a gas in an arbitrary electric field is determined from the time-dependent Boltzmann transport equation. The assumptions are: collision frequencies are dependent of energy and there are only elastic collisions. The solution is obtained for the case of a sinusoidally varying field and contrasted with a solution obtained on a more elementary level. (auth)

26915 (AD-609133) PROGRESS REPORT NO. 26 [ON MICROWAVE RESEARCH] APRIL 1, 1964–SEPTEMBER 30, 1964. Ernst Weber (Polytechnic Inst. of Brooklyn, N. Y. Microwave Research Inst.). 146p. $4.00 (CFSTI).

Research is reported on waveguides, effects of large perturbing surfaces on electromagnetic fields radiated by electric or magnetic current distributions, and network theory. Research on plasma electrophysics and electronics, solid state physics, microwave circuits, and communications and control systems is summarized. (J.R.D.)

26916 (GAMD-3639) COMMENTS ON THE BOUNDARY CONDITIONS AT AN ABLATING SURFACE. Nuclear Pulse Propulsion Project. M. J. Nowak (General Atomic, San Diego, Calif.). Nov. 6, 1962. Contract AF29(601)-2207. 10p.

A high temperature gas adjacent to a solid surface produces ablation of that surface, and this movement modifies the hydrodynamic boundary conditions at the surface. Considering the one-dimensional problem with all variations normal to the surface only, a description of the process as a discontinuity between the vapor and condensed phases is presented. The thermodynamic and hydrodynamic constraints were applied and some of the limiting cases were examined to estimate the importance of the uncertainty on the uncertainty on the overall behavior of the system. (W.L.G.)

26917 (IA-984) RESEARCH LABORATORIES SEMI-ANNUAL REPORT FOR THE PERIOD JANUARY–JUNE 1964. (Israel Atomic Energy Commission, Yavne. Soreq Research Establishment). Nov. 1964. 191p. Dep.(mn).

Operation of the IRR-1 reactor unit is summarized along with radioisotope production and development and radiation protection measures. Research progress is reported on high energy physics, elementary particle theory, reactor physics, nuclear physics, solid-state physics, and atomic physics. Progress is also reported in research on inorganic, radiation, nuclear, and analytical chemistry. Research on biology and medicine is summarized. Summaries of work on nuclear safety, environmental studies, industrial applications of isotopes, and activation analysis applications are included. Research progress on mechanical instrumentation and electronics is reported. (J.R.D.)

26918 (JINR-P-1990) STABILIZATOR MAGNITNOGO POLYA S SHIROKODIAPAZONNYM DATCHIKOM NA EPR. (A Magnetic Field Stabilizer With the Broadband Transducer Using Electronic Paramagnetic Resonance). Yu. N. Denisov, S. A. Ivashevich, and V. V. Kalinichenko (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1965. 14p. Dep.(mn).

A system for stabilization of the magnetic field of an electromagnet with a transducer based on EPR is described. The transducer is a short-circuited section of a waveguide and does not require exact tuning of the resonance frequency. The range of stabilized fields is 0.6 to 1.37 tesla. In carrying out the preliminary stabilization of the electromagnet supply current with an accuracy of $(1-5) \times 10^{-2}$% the instability in the absolute value of the stabilized field does not exceed $(1-3) \times 10^{-3}$%. (auth)

26919 (N64-18080) SPUTTERING AT OBLIQUE ANGLES OF ION INCIDENCE. Thomas W. Snouse (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). Apr. 1964. 27p. (NASA-TN-D-2235) $0.75(CFSTI).

The yield and angular distributions of sputtered material are given for nitrogen ions of energy 0.5 to 7.0 kev obliquely incident on polycrystalline copper. A model of the sputtering process is proposed and shown to be in qualitative agreement with the present experimental evidence and the work of others. In addition, the model gives the correct qualitative description of such measurables as the fall-off of yield at glancing angles of ion incidence, the mean kinetic energy of sputtered atoms, and the depth of origin of sputtered atoms. (auth)

26920 (NP-14938) RAYLEIGH'S PROBLEM IN MAGNETOGASDYNAMICS WITH HALL EFFECT. Pau-Chang Lu (Case Inst. of Tech., Cleveland, Ohio). 1965. Contract NSF-G19000. 36p.

The boundary-layer solutions for large times of the velocity and temperature distributions in a gas, induced by the impulsive motion of an infinite flat plate in its own plane, are obtained by using the Kármán-Pohlhausen technique. The gas is assumed to be thermally ionized through a combination of dissipative effects and heat supplied at the plate. Two examples are given for seeded argon at about 2500°K: one with Hall effect (strong magnetic field), and one without. An example of the corresponding "incompressible" problem is solved both approximately and exactly, to throw some light on the possible error involved in applying the Kármán-Pohlhausen technique to the present problem. (auth)

26921 (ORNL-3796) THE EFFECT OF ACCOMMODATION OF THERMAL TRANSPIRATION: LIMITATIONS OF THE "DUSTY GAS" MODEL IN THE DESCRIPTION OF SURFACE SCATTERING. E. A. Mason and A. P. Malinauskas (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 22p. Dep.; $2.00(cy), 1(mn) CFSTI.

The effect of gas-surface accommodation mechanisms on thermal transpiration at very low pressures is discussed. A comparison is made between a rigorous generalized formulation and results obtained from considerations of various types of gas-surface interaction as applied to the dusty gas model for gas transport. The types of scattering pattern considered are found to be inappropriate for use in describing the experimentally observed, low pressure, thermal transpiration anomalies. The proposal is made to account for the anomalous nature of the transpiration effect in the Knudsen region through the use of an additional experimentally determined parameter, and the effect of this alteration on equations which have been employed previously to describe the pressure dependence of thermal transpiration is discussed. (auth)

26922 (PR-P-64) PHYSICS DIVISION PROGRESS REPORT, OCTOBER 1 TO DECEMBER 31, 1964. (Atomic Energy of Canada Ltd., (Chalk River (Ontario). Chalk River Nuclear Labs.). 49p. (AECL-2201). Dep.; $1.50 (AECL).

Solid state detectors which are sensitive to the position at which the energizing particle enters were used in conjunction with an annular shape and radial position sensitivity to give good particle energy resolution and large sensitive area in heavy ion reaction studies. The detector is placed at 0° to the bombarding beam and the measured radial position of each event is passed on-line to a PDP-1 computer which calculates and compensates for the kinematical energy spread with angle over the large detector, permitting the full area of the detector to contribute to a

single energy peak. Preliminary results using this technique with the reaction $^{12}C(^{12}C,\alpha)^{20}Ne$ are reported. A Li-drifted Ge detector was used to study the γ-rays from the mirror nuclei ^{15}N and ^{15}O using the reactions $T(^{16}O,\alpha\gamma)^{15}N$ and $^{16}O(^{3}He,\alpha\gamma)^{15}O$. Each reaction shows a close doublet at about 5.2 Mev consisting of one sharp and one Doppler-broadened peak. A coincidence technique using the high resolution magnetic α-particle spectrometer and a 5 × 6-in NaI(Tl) scintillation counter is proving to be a powerful method for investigating the complex energy level scheme of ^{24}Mg. The reactions $^{12}C(^{16}O,\alpha)^{24}Mg$ and $^{25}Mg(^{3}He,\alpha)^{24}Mg$, are being used in the study. The triple axis crystal spectrometer at NRU was used to measure the complete frequency versus wave-vector dispersion relation for the normal modes of vibration propagating in the high symmetry directions of thallium bromide at 105 and 296°K. Calculations were carried out on the anharmonic effects to be expected in KBr and NaI. The calculations for KBr show that below 450°K the neutron groups for the acoustic and transverse optic modes are slightly temperature dependent, while the longitudinal optic mode is very temperature dependent at long wave-lengths. For NaI, however, the modes are very temperature dependent over the whole spectrum. Measurements on the energy-momentum dispersion curve for the excitations in liquid He at 1.5°K and extending to momentum transfer values of 3 $Å^{-1}$ were completed and analyzed. Further studies on the generation of intense neutron fluxes are being carried out. A number of programs were developed or improved for use on the G-20 computer. (J.R.D.)

26923 (TID-21850) OPTICAL CONSTANTS OF EVAPORATED METAL FILMS OF SILVER AND INDIUM (thesis). Russell Henry Huebner (Vanderbilt Univ., Nashville, Tenn.). June 1965. 61p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Optical constants of vacuum-evaporated silver and indium films were determined from reflectance data measured for light incident at 20 and 70°. Values of the real and imaginary parts of the complex index of refraction, n and k respectively, were evaluated by means of a computer program based on Fresnel's equations. The constants for evaporated silver were determined in the wavelength region from 2500 to 3700 Å and were compared with constants evaluated for bulk silver. The real and imaginary parts of the complex dielectric constant and the energy loss function were evaluated for evaporated silver. The constants for silver were obtained to investigate the discrepancy between the experimental optical emission studies from electron-bombarded thin silver foils and the generalized transition radiation theory with the optical constants of bulk silver used as input data. This discrepancy of about 30% in photon intensity at the peak of emission is removed when the constants for evaporated silver are used. Resonance absorption found in the transmission spectra of thin silver films was also investigated, and good agreement was observed between the measured spectra and the theoretical spectra based on Fresnel's equations using the optical constants determined for evaporated silver. Optical constants for evaporated indium were determined in the wavelength region from 1100 to 3000 Å, where no previous data were available. Comparison of optical constants at λ = 1100 Å with earlier data obtained in the region $\lambda \leq$ 1100 Å showed that values obtained by another worker were approximately 50 percent lower than the values presented here. Such differences in part are attributed to differences in structure of the films prepared in the earlier work and the present. The complex dielectric constant and the energy loss function were determined from the n and k values. These values indicate collective electron oscillation for indium which occurs approximately at λ = 1145 Å corresponding to an energy of 10.8 ev. (auth)

26924 (UCRL-12412) PROPAGATION OF DISTURBANCES. J. Hardy (Lawrence Radiation Lab., Univ. of California, Livermore). Feb. 22, 1965. Contract W-7405-eng-48. 16p. Dep.; $1.00(cy), 1(mn) CFSTI.

In a medium subject to a set of conservation equations, the necessary conditions on the propagation of a disturbance are presented. The evolutionary behavior of disturbances subject to these conditions is also presented. (auth)

26925 (JPRS-29075) NEWS OF HIGHER EDUCATIONAL INSTITUTIONS, MINISTRY OF HIGHER AND SECONDARY SPECIALIZED EDUCATION, USSR, RADIOPHYSICS SERIES. Translation of Izvestiya Vysshikh Uchebnykh Zavedenii, Radiofiz., 7: No. 5, 817-1011 (Sept.-Oct. 1964). 281p. (TT-65-30487). $6.00(CFSTI).

Thirty-one articles are included; separate abstracts have been prepared for 2. Six articles were previously abstracted in NSA, Vol. 19, as abstracts number 12331, 12332, 12653, 12654, 19277, and 19278. Those papers not abstracted separately cover such topics as theory of operation of electronic equipment, electromagnetic theory, molecular beams and molecular sources, electric discharge, and cosmic radio waves (atmospherics). (T.F.H.)

For abstracts of individual papers see: 26493 and 27290.

26926 GEOMETRY OF SPIRALLING PARTICLE-PATHS OF HIGH SPEEDS AFFECTED BY GRAVITATION. E. Chvojkova (Inst. of Astronomy, Czechoslovak Academy of Sciences, Prague). Bull. Astron. Inst. Czech., 16: 63-9(1965).

When the magnetic pressure exceeds the kinetic pressure, plasma particles become frozen in the magnetic field lines along which they are forced to spiral. In astrophysics or geophysics, where the effect of gravity can no longer be neglected, a plasma particle can become frozen even in a given point of the magnetic field line (around which it circles perpetually, incapable of sliding along the field line). This phenomenon appears only when the particle spirals with an extremely high velocity v_W which is about half of the escape velocity v_{esc}. It looks as though, under favorable conditions, all plasma particles of a plasma stream could become frozen. In general, however, the spiralling particles are trapped between two reflecting levels $r_{(1)}$ and $r_{(2)}$ beyond which they cannot proceed. The lower is the magnetic mirror r_H, and the upper one, r_g, is the top altitude a spiralling particle can attain in the gravity field. In the point r_W, where the particle path has a minimum deviation i from the magnetic field line, its velocity is just v_W. Below the point r_W, it spirals with greater velocity (and around smaller circles) than above r_W. Hence, slow particles (above r_W) show the tendency to contract towards the center since their spiral path gets squeezed when it moves upwards and opens wide when it moves down. Similarly, particles with a velooity exceeding v_W show the tendency to expand outwards. Particles reflected with velocity v_W are frozen since both their reflecting levels have fallen together. These observations could perhaps explain phenomena observed on eruptive prominences, planetary nebulae, novae or van Allen belts. They might perhaps even explain why novae or eruptive prominences burst with such violent velocities. (auth)

26927 ON OXYGEN QUENCHING OF POSITRONIUM IN LIQUIDS. D. P. Kerr, A. M. Cooper, and B. G. Hogg (Univ. of Manitoba, Winnipeg). Can. J. Phys., 43: 963-5(May 1965).

Measurements of the long lifetime (τ_2) for positron annihilation in oxygen-saturated, air-saturated, and degassed hexane gave conversion rates of 7.5×10^8 sec^{-1} and 1.5×10^8 sec^{-1} for the first two. It is concluded that the conversion mechanism is not responsible for the quenching of τ_2 in hexane. Earlier work reported that the presence of dissolved oxygen severely quenches τ_2 for positron annihilation in some organic liquids. (F.S.A.)

26928 THE ALFVÉN FLOW IN THE PRESENCE OF THIN PROFILES. Lazare Dragos (Universite, Bucharest). Compt. Rend., 260: 2985-7(Mar. 15, 1965). (In French)

The flow of an incompressible fluid with arbitrary electric conductivity, in the presence of thin profiles, was studied (Arch. Rat. Mech. Anal., 13: 262(1963)) within the framework of the linearized theory. The solution was obtained with the aid of Fourier integrals by introducing the rotational and potential parts of the velocity and the magnetic fields. The representation obtained is no longer valid in the case of fields aligned to infinity and in the hypothesis that the fluid velocity is equal (at infinity) to the Alfvén velocity. A study of this particular case is made. (tr-auth)

26929 ELECTROMAGNETIC DETECTION OF NUCLEAR EXPLOSIONS. Robert W. Cotterman (ITT Kellogg Communications Systems, Chicago). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12, No. 2, 99-103 (Apr. 1965).

The detection of nuclear explosions by the electromagnetic radiation emitted is discussed, with consideration of the electromagnetic signals (particularly a radio flash), interference by signals from lightning, and signal discrimination techniques. Systems for the detection of atomic explosions at short and medium ranges are outlined. (D.C.W.)

26930 STABILIZATION OF A WEAK INHOMOGENEOUS MAGNETIC FIELD BY MEANS OF NUCLEAR MAGNETIC RESONANCE. A. I. Zhernovoi and O. V. Stakhov. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 164-5(Jan. 1965). (In Russian)

Difficulties are encountered in stabilizing weak inhomogeneous magnetic fields by the nuclear magnetic resonance method because the inhomogeneity of the field calls for the use of a small transducer, while its weakness requires the use of a large one. These difficulties can in part be obviated by the use of the nuclear magnetic resonance head with a flowing resonating liquid, because the volume of liquid in the field to be stabilized can be kept small while the volume in the polarizing field, which determines the signal to noise ratio, is made large. A new difficulty arises, however: the system tends to oscillate because of the time lag between the presence of the working liquid in the stabilized field and its appearance in the polarizing field where the signal is delivered. It is proposed to avoid such oscillation by employing fast negative feedback circuits. A system for stabilizing the magnetic field of a $\pi\sqrt{2}$ spectrometer is described briefly. Smooth control of the stabilized field is to be achieved by employing the beat frequency between a variable audio oscillator and a high-frequency crystal-controlled oscillator as the reference frequency for the nuclear magnetic resonance head. (ATD)

26931 EQUIPMENT FOR STABILIZATION OF INHOMOGENEOUS MAGNETIC FIELDS, BASED ON ELECTRON PARAMAGNETIC RESONANCE. S. P. Pivovarov, Yu. A. Ryabikin, A. I. Zhernovoi, and G. D. Latyshev. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 166-7(Jan. 1965). (In Russian)

Apparatus is briefly described with which a stabilization factor of 100 was achieved in the stabilization of a 165-Oe magnetic field with inhomogeneities of the order of 2 to 10% per cm by the use of an electron paramagnetic resonance head, the linear dimensions of which did not exceed 2 mm. The stabilization achieved was actually limited by the frequency stability of the oscillator employed and could be increased by employing a more stable oscillator. The theory of paramagnetic field stabilization is discussed briefly. The advantage of electron paramagnetic resonance over nuclear paramagnetic resonance for this application is due to the greater magnetic moment of the electron. (ATD)

26932 SPIN-OSCILLATOR-TYPE STABILIZER FOR MAGNETIC FIELDS. V. V. Ekaterinin, A. I. Zhernovoi, and V. D. Shevelenko. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 168-71(Jan. 1965). (In Russian)

A magnetic field stabilizer of the type proposed by Vladimirskii and Labzov was built, and its operation is discussed. Such a stabilizer is suitable for use with a magnetic spectrometer, since the small local modulation of the field attendant on the spin coupled oscillations does not appreciably affect the operation of a spectrometer. The side band generator was crystal controlled and operated at frequencies from 300 to 3000 cps. The side band was mixed with the paramagnetic resonance signal in a bridge with strong inductive coupling. The quality of this bridge was such that the paramagnetic resonance head could be located as far as 20 meters from it. The signal from this bridge was detected with an ordinary superheterodyne receiver, the output of which served to modulate the field and, with an RC type frequency discriminator set at 1.5 kc, to control it. A control factor of 100 was realized. (ATD)

26933 EFFECT OF NUCLEAR NUTATION IN INHOMOGENEOUS MAGNETIC FIELDS. A. I. Zhernovoi, A. I. Polyakov, and G. I. Yakovlev. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 304-5(Feb. 1965). (In Russian)

Nuclear magnetic resonance measurement of magnetic fields by means of a head employing a flowing working substance is considered. In instruments for this purpose it is necessary to effect a rotation by at least 270° of the mean nuclear magnetization of the working substance by interaction with a resonant high-frequency field in the presence of a static magnetic field. This is difficult to achieve because of the inhomogeneity of the applied magnetic field. Realization of the requisite degree of magnetization reversal is greatly facilitated by application of an alternating magnetic field of amplitude equal to the inhomogeneity of the constant magnetic field and frequency such that 5 to 10 cycles are completed during the passage of a particle of the working substance through the field. This phenomenon is briefly discussed theoretically, and some experimental results are presented. The effect is sufficiently sensitive to the amplitude of the alternating field that it can be employed to estimate the inhomogeneity of the constant field. In the operation of the nuclear magnetic resonance head it is not only desirable to keep the nutation relaxation time (which depends on the inhomogeneity of the field) as small as possible but also to keep the time spent by a particle of the working substance in the field short compared with the relaxation time. (ATD)

26934 CONCERNING THE WIDTH OF THE NUCLEAR MAGNETIC RESONANCE LINE IN A FLOW PROBE. A. I. Zhernovoi, A. I. Polyakov, and G. I. Yakovlev. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 311-12(Feb. 1965). (In Russian)

Nuclear magnetic resonance measurement of magnetic fields by means of a head employing a flowing working substance is considered. It is pointed out that the nuclear magnetic resonance line is broadened as a result of saturation by the high-frequency field, distortion of the high-frequency field in the region of the head, and inhomogeneities of the static field in the directions parallel and perpendicular to the flow of the working substance. These effects are discussed very briefly, and some experimental results are presented. In order to obtain optimal results (minimum width of the nuclear magnetic resonance line) it is desirable to orient the head so that the flow of the working fluid is parallel to the gradient of the magnetic field and to select optimal values of the flow rate and the strength of the high-frequency field. (ATD)

26935 NONRESONANT NUTATION IN NUCLEAR MAGNETIC RESONANCE. A. I. Zhernovoi, A. I. Polyakov, and G. I. Yakovlev. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 313-14(Feb. 1965). (In Russian)

Nuclear magnetic resonance measurement of uniform magnetic fields by means of a maser employing a flowing working medium is considered. The alignment of nuclear spins by nonresonant nutation is discussed briefly, and a simple maser based on this principle is described. This maser operated in a 35-Oe field and employed water as the working substance. The protons were polarized in the 8-kOe field of a permanent magnet, and the water flowed through a region in which the magnetic field, transverse to the flow, changed sign twice. (ATD)

26936 DETERMINATION OF INCOMING SPHERICAL RADIATION IMPEDANCE INTRODUCED INTO INFINITE CONDUCTING MEDIA. S. M. Aksel'rod, R. A. Mustafaev, and K. F. Shirinov. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz. Tekhn. i Mat. Nauk, No. 1, 35-41(1964). (In Russian)

An incoming impedance of a spherical vibrator with a given radius a excited in the equatorial plane gap by an outside electromotive force of frequency ω, placed into an infinite homogeneous and isotropic medium with an assigned dielectric penetrability, specific conductivity, and magnetic penetrability was found using the classical method similar to that used for the free space. (R.V.J.)

26937 A STUDY ON ELECTRON DIFFUSION IN X-RAY MICROANALYZER SPECIMEN. Ryuichi Shimizu and Gunji Shinoda (Osaka Univ.). Japan. J. Appl. Phys., 4: 241-2 Mar. 1965).

The escape of electrons from a wedge-shaped copper

specimen traversing an electron beam was measured, together with the specimen current. The results were compared with theoretical results. (D.C.W.)

26938 SIMPLE IMPROVEMENT OF NMR-SIGNALS FOR MAGNETIC FIELD MEASUREMENTS. V. Dose (Universitat, Zurich). Nucl. Instr. Methods, 34: 253-4(May 1965).

The usual procedure for using NMR for accurate magnetic field measurements and stabilization is outlined. A method for suppressing the noise ("potato") with the frequency of the first harmonic, which appears with the reduction of bandwidth, is discussed. (C.E.S.)

26939 EXPERIMENTS WITH MAGNETOHYDRODYNAMICALLY SUPPORTED SHOCK LAYERS. E. Locke, H. E. Petschek, and P. H. Rose (Avco-Everett Research Lab., Everett, Mass.). Phys. Fluids, 8: 872-85(May 1965).

Shock tube experiments were performed to quantitatively determine the interaction of a hypersonic flow with the magnetic field of a straight current-carrying wire oriented perpendicular to the flow direction. The interaction which takes place in a thin layer behind a deteched shock wave is subject to the following restrictions: Negligible conductivity upstream of the shock, low magnetic Reynolds number, and scalar conductivity in the shock layer. The straight wire geometry under these restrictions was analyzed theoretically by Levy and Petschek. The analysis, which is briefly reviewed, predicts the location of a thin shock layer which is concentric with the wire. Most of the experimental work was performed in a 50-50 mixture of argon and oxygen, at an initial pressure of 1 mm Hg, and in a range of shock velocities between 4.3 and 6 mm/μsec. Data were obtained by observing the flow luminosity, using an image converter and mirror camera looking both perpendicular to and along the wire. A circular shock front was observed to stand up to $5\frac{1}{2}$ cm in front of a 1-cm-radius cylinder producing the magnetic field. The data on shock position versus current were in surprisingly good agreement with theory in view of the fact that at a density ratio across the shock of 0.25 the theory was not expected to predict the shock position to accuracies better than a factor of two. (auth)

26940 ROUND LAMINAR JET IN AN AXIAL MAGNETIC FIELD. D. P. Hoult (Pennsylvania State Univ., University Park). Phys. Fluids, 8: 886-9(May 1965).

The flow of an axisymmetric jet of a conducting liquid in a uniform axial magnetic field is studied. The magnetic Reynolds number is low, and the viscous Reynolds number, R, is high. The first terms of an asymptotic expansion of the solution are obtained. The momentum in the jet is not constant but decays linearly with the distance downstream of the orifice. The flow is confined by the magnetic field to a tube of diameter $R^{-\frac{1}{2}}$ which lies on the axis of the jet. (auth)

26941 KINETIC THEORY OF DENSE GASES. V. EVALUATION OF THE SECOND TRANSPORT VIRIAL COEFFICIENTS. David K. Hoffman and C. F. Curtiss (Univ. of Wisconsin, Madison). Phys. Fluids, 8: 890-5 (May 1965).

Numerical calculations of the corrections to the second transport virial coefficients due to three-body collisions are made for a Lennard-Jones gas, neglecting the effect of bound states. These results are compared with experiment. (auth)

26942 ASYMPTOTIC THEORY OF THE POSITIVE COLUMN OF A GAS DISCHARGE. Ira M. Cohen (Brown Univ., Providence) and Martin D. Kruskal. Phys. Fluids, 8: 920-34(May 1965). (MATT-202)

Within the positive column of a glow discharge a balance is struck between production of charged particles by ionizing collisions of electrons with neutrals and loss of charged particles by diffusion to the walls where they recombine. Since the column is assumed to be longitudinally uniform, it is the cross-sectional distribution of electric field and ion and electron densities that are found from a solution of the flux equations and Poisson's equation. In the limit $D_+/D_- \to 0$ ($D_{+,-}$ are diffusion coefficients), the relation between ionizing collision frequency and density of electrons at the center of the discharge, splits into two distinct regions. Within each of these regions the governing system of equations is reduced to a single second-order differential equation which is solved numerically, together with the associated boundary layers which are solved explicitly. Further, the large charged particle density (or small Debye length) limit is taken. The solution splits into a quasi-neutral main region and a space charge sheath boundary layer. The quasi-neutral solution is given to second order in the expansion. It is noted that the space charge sheath equations are equivalent to those solved earlier. The matching between the quasi-neutral and space charge regions is carried out to a high order in the expansions. A new and unexpected result is found—the ionization frequency tends to its limiting value for large charged particle densities from below—implying a minimum in the characteristic curve. (auth)

26943 EQUATION OF MOTION OF A DIELECTRIC MEDIUM. Allan N. Kaufman (Univ. of California, Livermore). Phys. Fluids, 8: 935-8(May 1965). (UCRL-7995)

Expressions for the macroscopic force density and stress tensor are derived for a noncrystalline dielectric medium in a nonequilibrium state. The calculation utilizes the exact Coulomb interaction between molecules with internal structure. (auth)

26944 NONLINEAR MODEL OF BOLTZMANN'S EQUATIONS FOR A MANY-COMPONENT GAS. Alan Oppenheim (New York Univ., New York). Phys. Fluids, 8: 992-3(May 1965).

An extension of the Welander-Krook model of Boltzmann's equation which includes collisions between the different components of a multicomponent gas is proposed. Although the description given is for two components, the generalization to more components is direct. (C.E.S.)

26945 PHASE TRANSITIONS IN SYSTEMS OF INTERACTING FERMIONS. S. Gartenhaus and G. Stranahan (Purdue Univ., Lafayette, Ind.). Phys. Rev., 138: A1346-56 (May 31, 1965).

Girardeau has shown that a particular class of variational approximations for the free energy of a Fermi-Dirac system may be expressed in terms of the exact free energy of a certain soluble model hamiltonian. This exact formula for the partition function associated with the model system involves the solution of a certain nonlinear integral equation, and in the present work it is shown in detail that there is a correspondence between phase transitions in the system and the existence of multiple solutions of this equation. The connection between the existence of phase transitions and the properties of the interaction is studied, and it is shown that these phase transitions may occur for a very wide class of interactions. It is established that there is an upper bound to the temperature, above which no phase transitions will occur at any density. The extension of these results to a classical and a Bose-Einstein system is indicated, and the lattice-gas model previously studied by Mermin is reexamined in the light of these results. (auth)

26946 REDUCED DENSITY MATRICES AND THE HARD-SPHERE BOSE GAS. Donald Wright (Case Inst. of Tech., Cleveland). Phys. Rev., 138: A1607-13(June 14, 1965).

The thermodynamic properties of the hard-sphere Bose gas are calculated from the one- and two particle density matrices. The one- and two-particle density matrices are evaluated in the Bogoliubov approximation. The off-diagonal elements of the one- and two-particle density matrices are studied for the presence or absence of off-diagonal long-range order in various temperature regions. Off-diagonal long-range order was found in the single-particle density matrix below the Bose-Einstein transition temperature. The two-particle density matrix also exhibited off-diagonal long-range order whenever the single-particle density matrix did. (auth)

26947 FIRST TOWNSEND IONIZATION COEFFICIENT IN HYDROGEN. D. E. Golden, H. Nakano, and L. H. Fisher

(Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Rev., 138: A-1613-16(June 14, 1965).

Rose's measurements of the first Townsend ionization coefficient η in hydrogen for $E/p_0 \geq 100$ v (cm torr)$^{-1}$ were questioned by a number of authors principally either because of a supposed neglect of the second Townsend ionization coefficient γ, or because electrons allegedly do not have an energy distribution which is only characteristic of E/p_0, or because of gas purity. In order to resolve these questions, new measurements of η in hydrogen were carried out for $50 \leq E/p_0 \leq 800$ in an ultrahigh-vacuum system. This work takes γ into account, and the values of η obtained are in agreement with those of Rose over the whole range of E/p_0 studied. Various methods of evaluating η from prebreakdown ionization currents are critically discussed. The present results show that prebreakdown ionization-current data in hydrogen can be represented in the usual way, at least up to $E/p_0 = 800$. (auth)

26948 CONTINUITY BETWEEN BOUND AND UNBOUND STATES IN A FERMI GAS. W. Kohn and C. Majumdar (Univ. of California, San Diego, La Jolla). Phys. Rev., 138: A1617-20(June 14, 1965).

A soluble model of a gas of independent fermions in the presence of an attractive localized potential $\lambda v(r)$ is considered. It is shown that the properties of the system as a whole are smooth (analytic) functions of λ, even at those values of λ where new single-particle bound states appear. Thus for the system as a whole, the transition from screening to binding is smooth and the concept of a bound state cannot be given a sharp meaning. Implications for certain metals and alloys are discussed. (auth)

26949 ELECTROMAGNETIC FIELD IN THE NEIGHBORHOOD OF THE FOCUS OF A COHERENT BEAM. A. Boivin (Laval Univ., Quebec) and E. Wolf. Phys. Rev., 138: B1561-5(June 21, 1965).

An integral representation for the electromagnetic field in the region of focus of a coherent light beam that emerges from an aplanatic optical system has been derived by Ignatowsky and by Richards and Wolf. This representation is used to analyze the structure of the focal region in a typical case. Contours of the time-averaged electric energy density in the focal plane, in one defocused plane and in two meridional sections of the focal region of a system with angular semi-aperture 45° are presented. The meridional diagrams refer to axial sections through a cylindrical region around the axis near focus, of length 16λ and cross-sectional diameter 10λ, where λ is the wavelength of the light. It is found that the field has a strong longitudinal component at certain points of the focal plane and that longitudinal electric field strengths of the order of 10^5 v/cm could now be attained with focused laser beams. A diagram illustrating the complete behavior of the longitudinal component in the focal plane is also given. (auth)

26950 CONCEPTS OF SPACE-TIME IN PHYSICAL THEORIES. NON-SPATIO-TEMPORAL DESCRIPTION OF NATURE. Takao Tati (Univ. of Kanazawa, Japan). Progr. Theoret. Phys. (Kyoto), Suppl., No. 29, 1-96(1964).

A physical description is outlined in which space-time is not presupposed. Several existing classical and quantum theories are defined on the basis of axioms that do not presuppose the concept of space-time. A theory of elementary particles with a finite degree of freedom is defined. (D.C.W.)

26951 IS THE SPACE-TIME CONCEPT NOT PRESUPPOSED REALLY IN TATI'S THEORY. A COMMENT ON THE SPACE-TIME DESCRIPTION OF EXTENDED PARTICLES. Rokuo Kawabe (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., No. 29, 97-107(1964).

An argument on Tati's "non-spatio-temporal" description is presented, especially with respect to its conceptual construction on the motion of matter. Some considerations on the space-time description of extended particles are also included. (auth)

26952 APPROXIMATE ANALYTICAL EXPRESSION FOR THE PATH OF PARTICLES DELAYED ACCORDING TO THE BETHE LAW. A. A. Ostroukhov and N. G. Nakhodkin. Radiotekhn. i Elektron., 10: 522-9(Mar. 1965). (In Russian)

Approximate analytical expressions for the total mean path of charged particles, delayed according to the Bethe law, were found, along with the expression for the energy decrease of the particles along their linear path. Formulas obtained with high precision showed the significance of these values in intervals of primary energy limited by applicability of the Born approximation and by the relativity effects. An approximate evaluation was made of the value of the scattering path and angular scattering of the electron beam. The results of the calculations were compared with experimental data. (tr-auth)

26953 IMPACT IONIZATION COEFFICIENT α, MEAN ELECTRON ENERGIES, AND THE MOBILITY OF ELECTRONS IN GASES. Hans Schlumbohm (Universitat, Hamburg). Z. Physik, 184: 492-505(1965). (In German)

From the analysis of oscillograms of electron avalanches values of the ionization coefficient α for electrons were determined for oxygen, methane, carbon dioxide, and some organic vapors at E/p-values between some 100 and several 1000 volts/cm torr. Over a certain E/p-region the values satisfy the relation $\alpha/p = A \exp(-Bp/E)$ for which the constants are given. Values of the mean diffusion energy D/b of the electrons were determined for oxygen, nitrogen, hydrogen, and some other gases and vapors ranging from 4 ev at $E/p \approx 50 - 100$ to some 20 ev at E/p of several 1000 volts/cm torr. These values of the diffusion energy are in agreement with those obtained from values of the ionization coefficient α. The mobility of the electrons is calculated in dependence on the energy D/b and compared with experimental values. It is shown that satisfactory agreement is obtained only when the first two terms of the expansion of the velocity distribution are taken into account. (auth)

26954 INVESTIGATION OF DIFFERENT ELECTRON EMISSION PROCESSES FOR MULTIFOLD EMISSION. Manfred Herrmann (Universitat, Mainz). Z. Physik, 184: 352-4(Apr. 15, 1965). (In German)

A comparison of the pulse height distribution of several electron emission processes is drawn. Thermionic electrons, photoelectrons, field electrons, and exoelectrons are found to be emitted as single electrons. (auth)

26955 HAGEN-POSEUILLE FLOW IN A CYLINDRICAL WALL STABILIZED ELECTRIC ARC. H. J. Patt and G. Schmitz (Technische Hochschule, Aachen). Z. Physik, 185: 1-18(1965). (In German)

An attempt is made to examine the properties and parameter dependences of the electric, thermal, dynamical, and radiation quantities of a Hagen-Poseuille flow in a cylindrical wall-stabilized electrical arc. The basic equations are derived from the single fluid model of plasma physics taking into account the special arc conditions. For this flow it is outlined, that the temperature distribution and hence the electric and radiation quantities do not depend upon the dynamical entities in the considered parameter region. The determination of these functions can be performed in the same way, which was previously demonstrated for the electrical arc without convection. Knowing the temperature distribution it is possible to calculate the dynamical quantities, which are modified by the temperature field of the arc contrary to the isothermal flow. Corresponding to this they have different parameter dependences as shown by analytical and numerical treatment for a nitrogen and an argon arc. (auth)

26956 THE HALL COEFFICIENT OF THE SMALL POLARON. J. Schnakenberg (Universitat, Cologne). Z. Physik, 185: 123-38(1965).

The Hall coefficient of the small polaron in the Holstein model suitably generalized to three dimensions and to the presence of a magnetic field is calculated by means of the Kubo formula. A perturbation expansion of the correlation function appearing in the Kubo formula is used to introduce higher order jumps of the polaron which are the first to be affected by the magnetic field. A general expression for the Hall coefficient is obtained which esse-

tially coincides with the result of Friedman and Holstein obtained for special cases. Moreover, it is shown that interference processes of thermal activation and free motion of the small polaron change the Hall effect, and their contribution to the value of the Hall coefficient is calculated. (auth)

26957 ON THE USE OF THE EFFECTIVE POTENTIAL METHOD IN RELATIVISTIC ELECTRON OPTICS. A. M. Strashkevich (Kiev Polytechnic Inst.). Zh. Tekhn. Fiz., 35: 185-5(Feb. 1965). (In Russian)

The discrepancy between the Strashkevich and the Shtepa relativistic paraxial trajectory equations for a transaxial lens is traced to Shtepa's incorrect use of Boguslavskii's equivalent potential method. Unlike the true potential, the equivalent potential is not a solution of Laplace's equation and thus may be substituted for the true potential only before simplifications using Laplace's equation are introduced. A simple illustration is given. (ATD)

26958 ON THE DISTRIBUTION OF ION CURRENT IN PENNING TUBES. Yu. E. Kreindel (Tomsk Inst. of Radio Engineering and Electronics, USSR). Zh. Tekhn. Fiz., 35: 315-16(Feb. 1965). (In Russian)

The sputtering patterns on the cathodes of Penning tubes operated under a variety of conditions were examined to obtain information concerning the ion current distribution in the Penning discharge. The tubes were all axially symmetric and were pumped continuously. The cathodes were foils of different metals. Most of the observed sputtering patterns could be classified into axially symmetric or rhombic. The axially symmetric pattern was usually observed at pressures above 10^{-3} mm Hg; the sputtering intensity was independent of azimuth and decreased with increasing distance from the center. In the rhombic pattern, observed mostly at pressures below 5×10^{-4} mm Hg, the sputtering intensity was relatively low at the center of the cathode and was maximum on the periphery of a rhombus. Cruciform sputtering patterns were also sometimes observed. Staining of the cathode was sometimes observed at pressures between 10^{-5} and 10^{-6} mm Hg. The stain was presumably due to decomposition of pump oil molecules by incident ions. The stain patterns were rhombic or cruciform. It is concluded that stable ion current distributions not possessing axial symmetry are possible in axially symmetric discharge tubes. (ATD)

26959 PROPAGATION OF A PULSE OF ELECTROMAGNETIC FIELD IN MOVING MEDIUM. G. Ya. Sermon and B. D. Zheigur. p.91-9 of "Voprosy Magnitnoi Gidrodinamiki. IV." Riga, Publishing House of Latvian SSR, 1964. (In Russian)

Experimental and theoretical studies were made on the interaction of a rectangular winding which undergoes a step change in current with another rectangular winding which moves with a velocity v. Equations are developed for the electric field of the resulting dipole by taking Laplace transforms of the equation for the vector potential. Experimental measurements were made by placing 2 rectangular 3×6 cm windings in 0.5-cm gap between two copper discs 60 cm in diameter (one winding attached to each disc). The relative velocity of the two windings was 10 m/sec. Experimental and theoretical curves of the change in the electric field are in good agreement. (TTT)

Accelerators

Refer also to abstracts 26702 and 27206.

26960 (BNL-8662) THE FAST KICKER OF THE AGS EXTERNAL BEAM SYSTEM. Internal Report. E. B. Forsyth (Brookhaven National Lab., Upton, N. Y.). Oct. 27, 1964. Contract AT-30-2-GEN-16. 22p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The design of a pulser for the fast beam kicker of the Brookhaven AGS is described. The operational experience and experimental field distributions using this kicker are detailed. (T.F.H.)

26961 (BNL-8765) MULTITURN INJECTION IN THE AGS. M. Q. Barton (Brookhaven National Lab., Upton, N. Y.). Dec. 18, 1964. Contract AT-30-2-GEN-16. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A computer program is described whose purpose is to determine the domains of applicability and factors influencing multiturn injection into an AGS, and to find optimum parameters for use of this type of injection. Multiturn injection is found to be feasible. (T.F.H.)

26962 (BNL-8913) MULTIPLY PERIODIC RF STRUCTURES FOR PROTON ACCELERATION. S. Giordano (Brookhaven National Lab., Upton, N. Y.). Feb. 8, 1965. Contract [AT(30-2)-Gen-16]. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Beam-transmission characteristics of standing-wave $\pi/2$-mode structures for accelerating proton beams above 200 Mev are analyzed. The structures considered are multiply periodic and symmetrically loaded. Means for altering the shunt impedance and bandwidth characteristics of the structures are described. (T.F.H.)

26963 (BNL-8945) BEAM INSTABILITIES IN CIRCULAR ACCELERATORS. E. D. Courant (Brookhaven National Lab., Upton, N. Y. and Yale Univ., New Haven, Conn.). [1965]. Contract AT-30-2-GEN-16. 8p. (CONF-650306-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

Beam instabilities produced by space-charge detuning and plasma instabilities in high-beam-intensity circular accelerators are studied. Instabilities in colliding beams are also investigated, as applicable in storage ring beams. (T.F.H.)

26964 (BNL-8973) MACHINE OPERATION AT THE BROOKHAVEN ALTERNATING GRADIENT SYNCHROTRON. R. R. Adams, W. F. Gefers, and J. Spiro (Brookhaven National Lab., Upton, N. Y.). [Mar. 10, 1965]. Contract [AT(30-2)-Gen-16]. 6p. (CONF-650306-8). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

A description is given of the experimental facilities available at the 33 Bev Alternating Gradient Synchrotron (AGS). Using complex beam gymnastics to spill beam on several targets, it is possible to run simultaneous experiments at a number of energy levels. The logistics in planning and setting up experiments are discussed and a summary of machine operations for the year 1964 is presented. Improvements to increase the beam intensity, reliability, and flexibility of the machine are outlined. (auth)

26965 (BNL-9192) A MOTOR-GENERATOR RECTIFIER CONFIGURATION DESIGNED FOR FLAT-TOP. R. L. Cassel (Brookhaven National Lab., Upton, N. Y.). Apr. 1, 1965. Contract AT(30-2)-Gen-16. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A rectifier configuration was needed for use in the flat-top condition during the pulsing cycle of the Alternating-Gradient Synchrotron. The configuration chosen is a double 12-phase full-wave configuration with a 12-phase half-wave condition during phasing back, with eight additional rectifiers. The new configuration can operate at lower power dissipation and ripple during phase back. (D.L.C.)

26966 (CEAL-1016) MAGNETIC BOTTLE FOR PRODUCING POSITRONS AND POLARIZED ELECTRONS. Kenneth W. Robinson (Cambridge Electron Accelerator, Mass.). Feb. 19, 1965. Contract AT(30-1)-2076. 16p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The use of a magnetic bottle in conjunction with the CEA for producing high-energy positrons and polarized electrons is investigated. It appears to be possible to produce positrons with an intensity approaching 5 percent of the electron intensity, and polarized electrons with an intensity approaching the full electron intensity. The production of polarized electrons appears to be easier and more certain than the production of positrons. (auth)

26967 (CEAL-1018) A 475.76 MH_z LINAC CHOPPER. Gustav-Adolf Voss and Gilbert L. Nicholls (Cambridge

Electron Accelerator, Mass.). Mar. 29, 1965. Contract AT(30-1)-2076. 16p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The Cambridge Electron Accelerator uses an "S" band (2854.56 MH_z) linac as an injector, and a UHF (475.70 MH_z) synchrotron r-f acceleration system. A chopper is used to eliminate five out of the six linac bunches, and the sixth bunch can be injected at the optimum phase with respect to the synchrotron r-f voltage. This reduces synchrotron oscillation, and reduces beam loading on the r-f, thus allowing for much larger accelerated currents. The linac uses constant phase velocity waveguides ($v_p = c$). The energy of the electrons introduced into the linac determines the trapping efficiency and the phase angle of the electron bunch with respect to the linac traveling wave. The chopper situated between the gun and the linac waveguide, is a cylindrical 475.76 MH_z cavity operating in the TM_{010} mode. It provides one half of the injection voltage (70 kv) for the selected electrons. The other half is provided by the gun pulse. Besides increasing the synchrotron intensity, the chopper system produced many other additional benefits. (auth)

26968 (CERN-65-5) A DATA LINK FROM PS EXPERIMENTAL AREA TO MERCURY COMPUTERS. F. Marciano and H. J. Slettenhaar (European Organization for Nuclear Research, Geneva (Switzerland)). Feb. 4, 1965. 27p. Dep.(mn).

The linkages and operations involved in the use of a Mercury computer on-line with the CERN proton synchrotron are reviewed. The operating characteristics of the computer are described, with reference to its use in conjunction with a missing-mass spectrometer. (T.F.H.)

26969 (CERN-65-9) AUTOMATIC TUNING OF THE ACCELERATING CAVITIES OF THE CERN PROTON LINEAR ACCELERATOR. P. Bramham (European Organization for Nuclear Research, Geneva (Switzerland)). Mar. 1, 1965. 51p. Dep.(mn).

A servo system is used to vary the tuning of each cavity of the linear accelerator (which injects protons into the CERN Proton Synchrotron) in order to keep a chosen phase relation between the field in the cavity and a radio-frequency reference common to all cavities. Descriptions are given of the connections to the cavities, the phase-sensitive bridges, the storage of information between the pulses of radio-frequency power, and the arrangements for applying the error signal to a motor which moves a part of the cavity wall. The servo system is analyzed by means of the Bode diagram. (auth)

26970 (JINR-P-1981) POLUCHENIE REZONANSNYKH CHASTOT RADIAL'NYKH KOLEBANII V RELYATIVISTSKIKH TSIKLOTRONAKH. (The Obtaining of Resonance Frequencies of Radial Oscillations in Relativistic Cyclotrons). V. P. Dmitrievskii, V. V. Kol'ga, and N. I. Polymordvinova (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1965. 17p. Dep.(mn).

A method is described of varying the radial oscillation frequency in a relativistic cyclotron by introducing a harmonic order N/2 into the magnetic field structure. It is shown that, when the 4th harmonic is introduced at the limit radius into the magnetic field structure of the 700-Mev relativistic cyclotron, the amplitude being 4% of the value of the average field, the frequency of radial oscillations increases from 1.8 to 2.0. (auth)

26971 (JINR-P-1984) ELEKTROSTATICHESKOE POLE RAVNOMERNO ZARYAZHENNOGO PARALLELEPIPEDA. (An Electrostatic Field of a Uniformly Charged Parallelepiped). V. I. Danilov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1965. 11p. Dep.(mn).

The electrostatic field produced by a rectangular parallelepiped is calculated, assuming that the charges are distributed uniformly inside its volume. The expressions describing the components of the electrostatic field are obtained. Some special cases are treated. Results can be used to estimate the effect of the space charge of the accelerated particles on their motion as well as on the intensity attainable in accelerators. (auth)

26972 (JINR-P-1985) UVELICHENIE DLITEL'NOSTI IMPUL'SOV PUCHKOV CHASTITS SINKHROTSIKLOTRONA OIYAI NA 680 Mev. (The Increase of the Pulse Duration of Particle Beams at a 680-Mev Synchrocyclotron of the Joint Institute for Nuclear Research). V. I. Danilov, I. B. Enchevich, B. I. Zamolodchikov, E. A. Polferov, E. I. Rozanov, V. I. Smirnov, and V. G. Testov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1965. 12p. Dep.(mn).

A method of increasing the duty cycle of the particle beams is described. It was tested at the JINR synchrocyclotron. The method is based on an excitation of the forced radial oscillations of the beam by the local inhomogeneity of the magnetic field variable in time. The magnetic field perturbation is produced by a pair of coils supplied by the current pulses with a half-conduction angle of 90° and located at a radius of 265 cm. The pulse duration of the meson beam was increased 5–6 times and is about 2500 μsec at the level of intensity 0.5. (auth)

26973 (LA-DC-6765) AN 805-MC 1-1/4-MW AMPLIFIER FOR ACCELERATOR SERVICE. D. C. Hagerman, J. D. Doss, R. W. Freyman, and J. R. Parker (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract [W-7405-eng-36]. 5p. (CONF-650306-29). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

An 805-Mc 1¼-Mw amplifier was constructed for test and evaluation as a power source for accelerator service. The amplifier was designed for 6% duty factor and a maximum pulse length of 2 milliseconds. The amplifier is described and preliminary test results are presented. (auth)

26974 (LA-DC-6780) ELECTRON ANALOG TESTS OF PROTON LINEAR ACCELERATOR STRUCTURE. John E. Brolley, Jr., C. Robert Emigh, and Donald W. Mueller (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1967]. Contract W-7405-eng-36. 9p. (CONF-650306-38). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

Electron analog tests of the 805-Mc clover-leaf accelerating structure being considered for the proposed Los Alamos linac have been made and are being extended. In the test which has been completed, 187-kev electrons, which are relatively easy to handle, are substituted for 343-Mev protons in the full-scale structure, which represents half of a prototype tank. The energy gain was measured using a lens filter system, which acts as a decelerating device that returns the electrons to zero energy. The additional voltage needed on the lens filter to stop electrons which were further accelerated by the cloverleaf model is a direct measure of the energy gain. The gain observed in the analog experiment corresponds to that expected from independent shunt resistance measurements. (auth)

26975 (LNF-65/4) SCHERMATURE PER IL LINAC DA 400 Mev DI FRASCATI. (Shielding of the 400-Mev Linac of Frascati). Note No. 270. M. Ladu and M. Pelliccioni (Laboratori Nazionali di Frascati, Comitato Nazionale per l'Energia Nuclear (Italy)). Feb. 18, 1965. 6p. Dep.(mn).

The calculations made with respect to the lateral and upper shielding of the Frascati linac in order to assure a level of scattered radiation (γ and neutrons) no higher than that recommended by the I.C.R.P. for external radiation were reported. The calculation is made by assuming that 10 μamp of electrons accelerated to 400 Mev are lost uniformly along the accelerator tube. (J.S.R.)

26976 (MURA-712) THE NUMERICAL DESIGN OF A RESONANT EXTRACTION SYSTEM FOR THE MURA 50-Mev ELECTRON ACCELERATOR. Philip F. Meads, Jr. (Midwestern Universities Research Assn., Stoughton, Wis.). Mar. 1, 1965. Contract W-31-109-eng-38. 28p. (Dep.; $2.00(cy), 1(mn) CFSTI.

Detailed numerical investigations of a proposed half-integral resonant-extraction system for fixed-field,

alternating-gradient synchrotrons verify the feasibility of extracting a high-quality beam from the MURA 50-Mev FFAG by this method. The half-integral resonance causes a large growth in the radial betatron amplitude, enabling the extraction of virtually the entire beam with an exceedingly small emittance. The method is complicated by the inclusion of time-varying parameters, required to maintain a relatively constant emittance and apparent source in the extracted beam over the extraction interval. Calculations were performed on an IBM-704 digital computer using measured magnetic fields. (auth)

26977 (MURA-714) MINUTES OF THE 1964 CONFERENCE ON PROTON LINEAR ACCELERATORS HELD AT MIDWESTERN UNIVERSITIES RESEARCH ASSOCIATION, JULY 20-24, 1964. F. E. Mills, C. D. Curtis, D. A. Swenson, and D. E. Young, eds. (Midwestern Universities Research Assn., [Stroughton, Wis.]). Contract [W-31-109-eng-38]. 642p. (CONF-650). Dep.; $9.42(cy), 12(mn) CFSTI.

Fifty-four papers are included; separate abstracts have been prepared for 42. Twelve papers were previously abstracted for NSA; see abstracts 18: 40086, 40087, 40088, 40089, 40090, 42793, 44319, 19: 9830, 9831, 9832, 14167, and 16325. (L.B.S.)

For abstracts of individual papers see: 26978, 26979, 26980, 26981, 26982, 26983, 26984, 26985, 26986, 26987, 26988, 26989, 26990, 26991, 26992, 26993, 26994, 26995, 26996, 26997, 26998, 26999, 27000, 27001, 27002, 27003, 27004, 27005, 27006, 27007, 27008, 27009, 27010, 27011, 27012, 27013, 27014, 27015, 27016, 27017, 27018, and 27019.

26978 (MURA-714(p.1-20)) R. F. ACCELERATING STRUCTURES: THE CROSS-BAR STRUCTURE. A. Carne (Rutherford High Energy Lab., National Inst. for Research in Nuclear Science, Chilton (England)).

Theoretical work, practical measurements on $\beta = 0.4$, $\beta = 0.56$ models, corresponding to 85 and 200 Mev, and further work on the 400 Mc cross-bar structure previously described for the CERN 200-Mev linac are reported. The formation of field patterns was derived on a basis of rectangular or square guide, and the fields were computed as if currents were carried on the centers of the bars. Measurements were made on the 400 Mc model to determine field patterns by axial field perturbation, and by magnetic loops through holes in the liner. The results are summarized. The results of the 800 Mc cross-bar model measurements are also presented; and it is concluded that the cross-bar structure has (η/Q) values between 2 and 3 times greater than the Alvarez structure in the range 100 to 200 Mev, and shunt impedances comparable with the Alvarez structure at 80 to 100 Mev, and better at 200 Mev. (L.B.S.)

26979 (MURA-714(p.31-59)) 800-Mev RF STRUCTURES. E. Knapp (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

The rf structures for proton linear accelerators, which may be operated in the π-mode, are considered: iris-loaded, crossed-bar, cloverleaf, basket-weave, loop-coupled pill-box cavities, and modifications of traveling wave amplifier tube structures. Structures which basically operate in the $\pi/2$ mode (resonant coupling) are also considered. The cloverleaf structure and a possible $\pi/2$ mode configuration which exhibits good shunt impedance are discussed in detail. (L.B.S.)

26980 (MURA-714(p.60-74)) CHARACTERISTICS OF SLOTTED IRISES. S. Giordano (Brookhaven National Lab., Upton, N. Y.).

Measurements of the shunt impedance, bandwidth, and other parameters of slotted iris structures in the π mode are reported for different bore hole diameters, drift tube lengths and cell lengths. The results were used as a preliminary for setting up a full-scale modeling program for slotted iris structures for proton linear accelerators. (L.B.S.)

26981 (MURA-714(p.75-83)) FABRICATION AND MEASURING METHODS FOR DISK-LOADED WAVEGUIDES. T. Nishikawa (Brookhaven National Lab., Upton, N. Y.).

New methods developed in Japan for fabricating disk-loaded guides with high accuracies and measuring their performance are reported. Some typical results of performance measurements are presented along with other results on the effect of hole shaping, tuning of each cell, and measurement of field distribution. (L.B.S.)

26982 (MURA-714(p.84-93)) THE 500-Mev LINAC PROPOSED AS A NEW INJECTOR FOR THE AGS AT THE BROOKHAVEN NATIONAL LABORATORY. G. W. Wheeler (Yale Univ., New Haven, Conn. and Brookhaven National Lab., Upton, N. Y.).

The principal characteristics of the 500-Mev proton linac proposed for the Brookhaven AGS are presented. The general parameters of the drift tube section, the waveguide section and a summary of drift tube tables are also presented. (L.B.S.)

26983 (MURA-714(p.108-9)) STUDY FOR A SUPERCONDUCTING MULTI-Gev PROTON LINAC. H. Schopper (Technische Hochschule, Karlsruhe (West Germany)).

The physical and technological problems of developing a superconducting cavity for a multi-Bev proton linac in Germany are briefly discussed. A group was previously established to investigate these problems, and the implications of such a project are outlined. (L.B.S.)

26984 (MURA-714(p.110-22)) THE NEW ZGS INJECTOR PROPOSAL. Rolland Perry (Argonne National Lab., Ill.).

The 200 Mev, high intensity injector system proposed for the ZGS is discussed, and the major components of the system are described. The parameters for the 750-kev preaccelerator, for the 200-Mev linac, and the performance specifications for the linac r-f system are given. (L.B.S.)

26985 (MURA-714(p.123-30)) PRELIMINARY DESIGN OF A HIGH-ENERGY HIGH-DUTY CYCLE PROTON LINEAR ACCELERATOR. H. Leboutet, G. Guilbaud, Kervesic, Mangin, Tran (Compagnie Générale de Télégraphie sans Fil, Orsay (France)).

The present status on the development of a proton linear accelerator for energies higher than 500 Mev, average current of 200 μamp, and duty cycle of 5%, for the production of intense π meson beams, is described. The general design and choice of the accelerating structures and frequencies are discussed. (L.B.S.)

26986 (MURA-714(p.131-43)) PROGRESS REPORT ON THE STANFORD LINEAR ACCELERATOR CENTER. G. A. Loew (Stanford Linear Accelerator Center, Stanford Univ., Calif.).

Some of the highlights of the present status of construction of the Stanford 20 Bev linear accelerator are described. The building construction, accelerator structure, drive and phasing systems, beam guidance, injection system, support and alignment, beam switchyard, and instrumentation and control are discussed. (L.B.S)

26987 (MURA-714(p.153-9)) DRIFT TUBE CALCULATIONS. Harry C. Hoyt (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

Mesh calculations performed for resonant cavities with symmetry with respect to an axis are described. The calculation divides the resonant cavity into a mesh containing a finite number of points, and then uses a finite difference scheme for computing the values for the magnetic field strength at the points in the mesh. Other quantities, such as the frequency, shunt impedance, and transit time factor, can then be computed. The voltage is also computed, which is used to determine the normalizing factor needed to eliminate the arbitrary constant which multiplies all the values for the magnetic field strength. (L.B.S.)

26988 (MURA-714(p.177-85)) DRIFT TUBE AND PARAMETER SELECTION FOR LINEAR ACCELERATOR STRUCTURES BELOW 150 Mev. D. E. Young (Midwestern Universities Research Assn., Stoughton, Wis.).

An attempt is made to arrive at a common design for drift-tube shapes for linear accelerator structures proposed by three different laboratories, which could lead to savings in design, engineering, and in procuring similar items in greater quantities. The recommendations proposed by the

committee for the drift tube design are presented, and consideration is given to the cost of building and operating a linac in terms of power and length. Nearly 2000 different geometries for cylindrical shaped drift tubes were investigated using the MURA field computational program. (L.B.S.)

26989 (MURA-714(p.186-203)) TRANSVERSE BEAM BLOW-UP IN STANDING WAVE LINACS. R. L. Gluckstern (Yale Univ., New Haven, Conn. and Brookhaven National Lab., Upton, N. Y.).

An attempt is made to formulate the two corresponding effects for the case of a standing wave accelerator. The build-up of deflecting modes due to the nonresonant effect that comes from the deflection of the beam by the transverse fields already present and the resonant build-up of the deflecting modes due to the transverse oscillations of the beam are calculated. It is found that both effects limit the contributions to those modes which slip no more than 180° behind the beam. Estimates of the magnitudes of the two effects have been made for the AGS improvement program parameters. (L.B.S.)

26990 (MURA-714(p.204-13)) DYNAMIC EFFECTS OF HIGHER RF HARMONICS. Frank J. Kriegler (Midwestern Universities Research Assn., Stoughton, Wis.).

The particle dynamics for beam-cavity interactions in an accelerator gap of an r-f cavity are investigated for cases in which a high proportion of the energy is removed from the cavity by one bunch of particles. The cavity is represented by an equivalent lumped RLC circuit upon which a sinusoidal voltage is impressed, the capacitor representing the accelerating gap of an r-f cavity. The steady-state solution is obtained by Fourier analysis of the beam current and the voltage waveform, from which higher harmonics are obtained. A plot of the equivalent circuit kernel and the ferrite loaded accelerating cavity kernel is given. Numerical results obtained using a MURA computer program are presented. (L.B.S.)

26991 (MURA-714(p.214-38)) AN APPROACH TO THE STUDY OF BEAM LOADING FOR THE LINEAR ACCELERATOR. T. Nishikawa (Brookhaven National Lab., Upton, N. Y.).

A method for studying the effects of beam loading in linear accelerators is presented, using the field equation for cavities and the equation of motion for the charged particles. It is assumed that a tightly bunched beam interacts with the field propagating along the cavity axis. The effect of induced field due to beam loading, the self-consistent field, and the beam blow-up effect are discussed. Wave propagation in a π-mode accelerator is also discussed. (L.B.S.)

26992 (MURA-714(p.239-51)) THE CERN-PS LINAC—BEAM LOADING AND RF STUDIES. C. S. Taylor and Y. Dupuis (European Organization for Nuclear Research, Geneva (Switzerland)).

The CERN-PS linac is at present accelerating currents of the order of 60 mamp and partial compensation of the beam loading is being provided by "bumps" on the r–f pulses. The evolution of this type of compensation is described, and the results of energy spread and emittance measurements with and without compensation are presented. An alternative method of supplying beam power from a supplementary power source is considered and preliminary tests are described. Measurements of the phasing between tanks and the velocity of propagation of fields along the walls of the cavities are also reported. (auth)

26993 (MURA-714(p.266-82)) PARTICLE MOTIONS AND THE FOCUSING SYSTEM IN PROTON LINACS. S. Ohnuma (Yale Univ., New Haven, Conn.).

Results of computer calculations for particle motions and the focusing system in proton linacs are presented. The results are mainly based on the design parameters of the proposed 500-Mev injector for the AGS in Brookhaven. (L.B.S.)

26994 (MURA-714(p.309-27)) FOCUSING OF AN ALVAREZ LINAC BY USE OF MAGNETIC QUADRUPOLES ORIENTED AT 45°. D. T. Tran (Compagnie Générale de Télégraphie sans Fil, (France) and Centre de Physique Electronique et Corpusculaire, Orsay (France)).

The acceptance of a system of magnetic quadrupoles is analyzed when the successive quadrupoles are oriented at an angle of 45° from one another. The quadrupoles are taken to be thin lenses, and it is assumed that the r-f defocusing is also that of a cylindrical thin lens, located at the middle of the gap. The results are compared with the classical arrangement. (L.B.S.)

26995 (MURA-714(p.328-40)) APPLICATION OF CALCULATED FIELDS TO THE STUDY OF PARTICLE DYNAMICS. D. A. Swenson (Midwestern Universities Research Assn., Stoughton, Wis.).

The PARMILA program was used to study the phase and radial motion of particles in linear accelerators, using information on the field distribution previously obtained from the MESSYMESH program. Exploratory runs were made to determine the transverse acceptance and the phase acceptance for an eight-tank 200-Mev linac. A brief description of the linac is given. (L.B.S.)

26996 (MURA-714(p.353-61)) PERFORMANCE OF THE PS LINAC. C. S. Taylor (European Organization for Nuclear Research, Geneva (Switzerland)).

The minor changes in the PS linac are briefly mentioned; some developments in the duoplasmatron, short column studies, instrumentation, and some practical aspects of operation are described. (L.B.S.)

26997 (MURA-714(p.362-71)) PERFORMANCE OF THE PLA. J. M. Dickson (Rutherford High Energy Lab., National Inst. for Research in Nuclear Science, Chilton (England)).

The operation and performance of the Rutherford proton linear accelerator is discussed, including availability figures since the start of regular operation in 1960 and lost time faults. Diagrams are presented of the linac monitor, the r-f level monitor, the intertank phase monitoring system, and the beam energy monitor. (L.B.S.)

26998 (MURA-714(p.372-83)) BEAM ENERGY MEASUREMENTS ON THE RUTHERFORD LABORATORY P.L.A. K. Batchelor, A. Carne, J. M. Dickson, and D. J. Warner (Rutherford High Energy Lab., National Inst. for Research in Nuclear Science, Chilton (England)).

The results of beam energy measurements on the Rutherford proton linac, using the time-of-flight method, are described. The effects of injection energies, r-f field levels, and intertank phases on the output energies of the linac are summarized. (L.B.S.)

26999 (MURA-714(p.398-406)) EXPERIMENTS ON RF FIELD PATTERNS IN THE BNL LINAC. J. T. Keane (Brookhaven National Lab., Upton, N. Y.).

The possible modes that can exist in a linac tank are reviewed and the results of model studies on the BNL linac tank are presented. It is found that the scallops observed on the r-f probe patterns of the linac tank are due to excitation of higher order model resonances. (L.B.S.)

27000 (MURA-714(p.407-13)) AUTOMATIC CONTROL AND STABILIZATION OF THE ORSAY LINAC. P. Brunet, L. Burnod, and L. Lheritier (Paris Univ., Orsay (France). Ecole Normale Superieure).

The present status of the Orsay linac is briefly discussed. Some of the systems which have improved the Orsay accelerator and some systems which will be incorporated in the machine extension from 1.3 to 2.8 Bev–klystron high voltage, automatic phasing system, temperature control and beam system control–are discussed. (L.B.S.)

27001 (MURA-714(p.414-28)) PROGRESS IN HIGH-INTENSITY ION SOURCE AND ACCELERATOR COLUMN DEVELOPMENT. A. van Steenbergen (Brookhaven National Lab., Upton, N. Y.).

A brief description is given of ion sources capable of producing total linac proton beam outputs of the order of 100 mamp. Equations for the source brightness and related beam emittance are developed for comparing the characteristics of various ion sources. The parameters for the

PIG, r-f, duoplasmatron, and ion sources using plasma expansion and plasma boundary focusing are tabulated. Developments in the design of an improved accelerator column structure are discussed. (L.B.S.)

27002 (MURA-714(p.430-46)) RECENT DEVELOPMENTS IN RF PROTON SOURCES. H. Wroe (Rutherford High Energy Lab., National Inst. for Research in Nuclear Science, Chilton (England)).

A description is given of the Nimrod r-f proton source, and its performance on a laboratory rig and on Nimrod is discussed. Future developments to improve the performance of the source are mentioned. (L.B.S.)

27003 (MURA-714(p.447-55)) RECENT MEASUREMENTS ON THE DUOPLASMATRON SOURCE. L. W. Oleksiuk (Brookhaven National Lab., Upton, N. Y.).

Emittance and beam brightness measurements were made for the BNL conventional (Mark I) duoplasmatron source to determine phase space densities and to study the effects of extracting the duoplasmatron ion beam from an expanded plasma. Measurements were also made for the Mark II duoplasmatron, consisting of a Mark I ion source with a modified extraction geometry. The results are reported, and it is shown that in general higher extracted currents with better brightness qualities can be obtained with the plasma expansion mode of extraction. (L.B.S.)

27004 (MURA-714(p.465-9)) THE PLA POLARIZED PROTON SOURCE. J. M. Dickson (Rutherford High Energy Lab., National Inst. for Research in Nuclear Science, Chilton (England)).

The history and engineering development of the polarized proton source for the Rutherford proton linear accelerator are briefly discussed. The instrumentation for measuring the polarization and intensity of the output beam and the absolute calibration of the polarimeter are described. Future modifications of the proton source are also discussed. (L.B.S.)

27005 (MURA-714(p.470-3)) ION SOURCE WORK AT ANL. D. H. Nordby (Argonne National Lab., Ill.).

A description is given of the ion source and the 15-inch constant acceleration-type column tested at ANL. Crude emittance measurements with the column and ion source combination run at 575 mamp and 120 kv indicate a beam quality improvement of a factor of 8 to 10 with a beam intensity increase of a factor of four over the 750 kv preaccelerator. (L.B.S.)

27006 (MURA-714(p.474-9)) AN EXTENDED RF ION SOURCE WITH SMALL PHASE SPACE EMITTANCE AREA. Rolland Perry (Argonne National Lab., Ill.).

Consideration is given to reducing beam divergence and minimizing the effects of space charge in the development of ion sources for partial accelerators. The general arrangement of the source is that of a hollow-donut-shaped cavity excited by an r-f power source. A conceptual design for the r-f source together with a spherical lens system is presented. (L.B.S.)

27007 (MURA-714(p.480-6)) A NEW APPROACH TO PREINJECTORS. H. Wroe (Rutherford High Energy Lab., National Inst. for Research in Nuclear Science, Chilton (England)).

A single gap acceleration experiment was performed using a pair of electrodes arranged in a vacuum vessel and a standard r-f source in the high voltage electrode operated at ground potential. With no beam present, the pressure effect was observed when a voltage was applied to the gap. A beam current of about 40 mamp was accelerated to −220 kv with breakdown of the gap at a pressure of 10^{-3} torr in hydrogen. The design of an ion source with 600 kv lead-in bushing is presented. (L.B.S.)

27008 (MURA-714(p.487-96)) PREACCELERATOR COLUMN DESIGN. C. D. Curtis and G. M. Lee (Midwestern Universities Research Assn., Stoughton, Wis.).

The removal of undesirable space-charge effects, reliability of operation against breakdown, and ion source accessibility are considered in the design of a high-current accelerating system. The scheme of a plasma expansion cup attached to a conventional duoplasmatron source was selected to provide for a large diameter beam. The column is enclosed in a pressurized filament-wound fiberglass vessel in order to reduce the possibility of voltage breakdown outside the accelerator column. The electrode and pressurized shell assembly designs are shown. (L.B.S.)

27009 (MURA-714(p.497-504)) THOUGHTS ON MODE DISTRIBUTION IN RF MANIFOLDS. F. Voelker (Lawrence Radiation Lab., Univ. of California, [Berkeley]).

An r-f manifold system is described. A long linear accelerator is paralleled with a transmission line, of which one end is short circuited so that an integral number of half-wavelengths exists along its length at the operating frequency of the linac. The typical modes in a π-mode r-f cavity are shown and an equivalent circuit is used to represent one cavity mode. Equations are derived for the propagation coefficients for the loaded manifold, and other modes are investigated. (L.B.S.)

27010 (MURA-714(p.520-30)) RECHARGING LARGE CAPACITOR BANKS. H. R. Shaylor (Brookhaven National Lab., Upton, N. Y.).

Consideration is given to the design of condenser recharging circuits with high recharge efficiency for large linacs. A single capacitor bank is considered as the most suitable alternative for the modulator energy storage system when the pulse length is too long to permit the use of a pulse transformer; the d-c plate voltage on the r-f power amplifier must be modulated to control the r-f amplitude in the linac tank. The basic circuit is shown, upon which an analysis of the energy dissipation, maximum capacitor voltage, peak charging current, and charging current at the end of the recharge period is made. A computer program was used to evaluate the formula, and the resulting plots are shown. Consideration is also given to continuously recharged capacitor systems. (L.B.S.)

27011 (MURA-714(p.531-2)) STATUS REPORT ON THE COAXITRON DEVELOPMENT PROGRAM. G. W. Wheeler (Yale Univ., New Haven, Conn.).

Performance specifications for the A15191 800 Mc coaxitron negative grid triode as a power source for proton linacs are presented. The demonstrated performance for a 900 Mc tube is given. (L.B.S.)

27012 (MURA-714(p.540-4)) RF SUPERCONDUCTIVITY MEASUREMENTS. J. M. Dickson (Rutherford High Energy Lab., National Inst. for Research in Nuclear Science, Chilton (England)).

The feasibility of designing a proton linear accelerator with superconducting cavities was studied. R-f measurements consisted of the measurement of the Q of resonant devices at 4.2°K and comparison of the results with Q of a similar resonant device of copper measured at room temperature. The results are reported for lead extrapolated onto copper with a standard commercial fluoborate solution, solid niobium wire, niobium deposited from $NbCl_5$ vapor, inhomogeneous superconductors such as Pb−Bi; eutectic and Nb_3Sn, and homogeneous alloys such as Nb−Zr and Mo−Re. Resonant cavities made by electroforming in copper and subsequent electroplating with lead were tested, and poor results were found for the improvement factors. The results were analyzed and were compared with other experimental results. (L.B.S.)

27013 (MURA-714(p.545-54)) DEUTERON ACCELERATION IN THE C.L.A. (CERN LINEAR ACCELERATOR). Th. Sluyters (Brookhaven National Lab., Upton, N. Y.).

Deuteron acceleration in the CERN linear accelerator is investigated for the case where the deuteron velocity is half the proton velocity in the 4π mode. The ratios of the energy gain per gap are obtained by calculating the effective available voltage for both particles. A more extensive investigation of axial motion was made by calculating linac phase acceptances for both particles as a function of mean accelerating field and tilt using a mercury autocode program for proton acceleration, and the results are shown. Experimental deuteron acceleration was investigated using

a standard r-f ion source assembly producing deuteron beam currents up to 100 mamps. The beam performance for optimum machine conditions is given. An analysis of beam trapping and phase acceptance was made and compared with theoretical results. (L.B.S.)

27014 (MURA-714(p.555-63)) THE ANL SECOND HARMONIC BUNCHER. W. Myers (Argonne National Lab., Ill.).

A multiple harmonic buncher system, which was designed and constructed for linacs to improve the capture efficiency of the injected beam, is briefly described. Theoretical phase space analysis was made to determine capture efficiencies, and phase space diagrams are presented for a first plus second harmonic buncher system and also for a four-harmonic buncher. (L.B.S.)

27015 (MURA-714(p.564-601)) A FAMILY OF IMPROVED LINAC BUNCHERS. R. Beringer and R. L. Gluckstern (Brookhaven National Lab., Upton, N. Y. and Yale Univ., New Haven, Conn.).

Bunchers that use an r-f deflector to separate phase regions in space so that each phase region can be bunched independently with a sinusoidal field are described. An analysis of the various deflector and buncher systems is presented. (L.B.S.)

27016 (MURA-714(p.602-5)) NIMROD INJECTOR. N. D. West (Rutherford High Energy Lab., National Inst. for Research in Nuclear Science, Chilton (England)).

The status of operation of the Nimrod injector is given. The prevention of multipactoring in the injector linac and in buncher and debuncher cavities by coating drift tubes and cavity surfaces with carbon black is discussed. (L.B.S.)

27017 (MURA-714(p.606-15)) INFORMAL DISCUSSION OF SPARKING PHENOMENA. (Midwestern Universities Research Assn., Stoughton, Wis.).

The sparking problems occurring in various proton linacs are discussed. Electric gradients for future linacs are also discussed. (L.B.S.)

27018 (MURA-714(p.616-21)) SUMMARY OF INFORMAL SESSION ON MECHANICAL ENGINEERING ASPECTS. John E. O'Meara (Midwestern Universities Research Assn., Stoughton, Wis.).

A discussion on the mechanical engineering aspects of a linac tank structure with external drift tube support and a 200-Mev cylindrical drift tube is summarized. Diagrams of both structures are presented. (L.B.S.)

27019 (MURA-714(p.622-6)) SUMMARY OF EVENING SESSION ON BEAM LOADING EFFECTS. J. Leiss (National Bureau of Standards, [Washington, D. C.]).

Problems related to beam loading in linear accelerators are briefly discussed: detuning, transient effects, subharmonic effects, tank flatness, phase shift effects, beam blow-up, space harmonics, beam loading limits, and reaction back on the source. (L.B.S.)

27020 (NIRL/R/80) AN IMPROVEMENT TO THE DUTY FACTOR OF THE HARWELL SYNCHROCYLOTRON. G. Huxtable and P. S. Rogers (National Inst. for Research in Nuclear Science, Chilton (England) Rutherford High Energy Lab.). Nov. 1964. 32p. Dep.(mn); $1.00(BIS); 5s. (HMSO).

The pulsed nature of a synchrocyclotron beam limits the accuracy obtainable in certain types of counting experiments, increasing the time necessary to perform an experiment to a given accuracy. The performance of the Harwell machine in this respect was improved by introducing auxiliary accelerating electrodes to control the beam just before it strikes the target. The rate of acceleration is arranged to slow down so that the beam is collected by the target at a slow and even rate which occupies the whole machine cycle. Performance figures are given. (auth)

27021 (NIRL/R/82) SOME NIMROD INJECTOR BEAM EMITTANCE MEASUREMENTS AT 15 Mev. J. T. Hyman (National Inst. for Research in Nuclear Science, Chilton (England). Rutherford High Energy Lab.). Nov. 1964. 13p. Dep.(mn); $0.50(BIS); 2s. 6d. (HMSO).

Measurements performed on the 15-Mev proton beam from the Nimrod Injector, using a combination of two fixed slits and two steering magnets, are described. The work of plotting emittance boundaries from experimental data can be greatly facilitated by the use of the special charts developed. (auth)

27022 (ORNL-P-1134) DEVELOPMENTS IN GRIDDED ION LENSES. J. W. Johnson (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 9p. (CONF-650306-52). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

For most applications, the use of grids in focusing elements can improve beam current densities per unit solid angle by a factor of 10 or more. The coupled problems of high grid transparency and long grid life have limited their usefulness in accelerator systems. The development of machined grids with a 10 fold increase in life expectance will be described. These grids are for the Einzel lens of the ORNL Nanosecond Pulser in which wire mesh grids had an average life to failure of 75 hrs. The grids were machined by electrical discharge (Elox) techniques in a sheet of tungsten or molybdenum. Transparencies as high as 84% have been obtained. The sheets can be pre-shaped to compensate for residual spherical aberrations in the lens. Shaped grids have shown further increases of beam brilliance of 30–40%. For fast pulsing operating in which there is no space charge neutralization, beam brilliance figures of 1 amp per sq cm per steradian have been obtained with beam currents up to 3 mA. (auth)

27023 (PPAD-2137-542) ANALYSIS OF LONGITUDINAL ACCELERATOR INSTABILITIES. Robert L. Pease (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Feb. 18, 1965. Contract AT(30-1)-2137. 19p. (CONF-650306-23). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

A sufficient stability condition for uniform coasting beams in cyclic particle accelerators is derived from Neil and Sessler's dispersion equation. Specific conditions are worked out for various injection patterns. The instability threshold depends fairly strongly upon the particle density distribution across the tank, and upon whether operation is below or above transition energy. For the latter case, the optimum distribution (allowing the largest number of particles in the beam) is derived. The possibility is investigated, using Nyquist diagrams, of injecting more particles by operating in a superstable state—one which depends for its stability on the low resistance of the tank walls. It is shown that any practical improvement by this means is probably illusory. (auth)

27024 (PPAD-2137-546) CALCULATION OF SPACE CHARGE EFFECTS IN BEAM TRANSPORT. R. C. Catura (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Mar. 10, 1965. Contract AT(30-1)-2137. 19p. (CONF-650306-61). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

Methods of calculating space charge effects which are presently available have as their basis the assumption of uniform charge density over the beam cross section. In design of a high intensity beam transport system, it is important to know how sensitive parameters of the design are to this assumption. This question was investigated by propagating phase plots along the beam axis for space charge fields from both a uniform charge density and a charge density obeying a normal distribution. Normalization was such that the field from the uniform density was a least-squares fit to the field from the charge density of normal distribution. Results of computations for 20 mamp of 3.9 Mev protons indicate that while the phase plot showed considerable distortion from effects of the normal charge density, parameters of the plot which affect design of a transport system were not changed appreciably. From

these calculations it seems that unless close matching of an acceptance phase plot is imperative, design of a transport system is relatively insensitive to charge distribution in the beam. (auth)

27025 (SLAC-36) HIGH-REPETITION-RATE PULSER FOR BEAM SWITCHING MAGNET. Technical Report, February 1965. J. L. Cole and J. J. Muray (Stanford Linear Accelerator Center, Stanford Univ., Calif.). Contract AT(04-3)-400. 53p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The optical properties of the pulsed magnet for the Stanford linac is discussed briefly. Detailed descriptions of the pulsed magnet modulators, the instrumentation for the magnet, and the test results are given. The problems connected with high-power switching at high repetition rates are also discussed. (auth)

27026 (UCRL-11783) A 600-kV, 10-mA dc COCKCROFT-WALTON RECTIFIER USING SILICON DIODES AT 100 kc. Louis L. Reginato and Bob H. Smith (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 2, 1965. Contract W-7405-eng-48. 16p. (CONF-650306-46). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

In this rectifier high-speed silicon diodes, etched circuit boards, and SF_6 are combined in a style of construction that requires only the modest shop facilities of any typical small physics laboratory. Construction techniques, performance tests, electronic regulation, high-speed protection circuitry, and application of the rectifier to experimental equipment are discussed. The technique described can be extended to larger sizes providing several million volts. (auth)

27027 (UCRL-11795) ELECTROSTATIC INDUCTION ELECTRODE SYSTEMS FOR BEAM-POSITION DETECTION. Allen J. Sherwood (Lawrence Radiation Lab., Univ. of California, Berkeley). Feb. 10, 1965. Contract W-7405-eng-48. 11p. (CONF-650306-27). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

Using the integral solution for the field and the reciprocity of the Green's Function, it is shown that the response of these devices to a line charge obeys Laplace's equation, if this operator is applied with respect to the source coordinates. In a cylindrical system of electrodes the boundary values of the response can be determined by inspection. Knowing these values, the response over the entire aperture can be found. This allows the use of electrodes of unusual shapes, e.g., sections of the beam tube. (auth)

27028 (UCRL-11808) DESIGN CONCEPTS OF MODERN ACCELERATOR VACUUM SYSTEMS — PREDICTION VS. EXPERIMENTAL DATA. Finn S. Reinath and D. T. Scalise (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 8, 1965. Contract W-7405-eng-48. 14p. (CONF-650306-43). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

Design parameters for accelerator vacuum systems are studied with reference to the requirements which appear in modern strong-focusing machines. The two major problems considered are restrictions in both pumpdown time and system base pressure created by trends toward very small apertures. Basic kinetic equations are used in a method of estimating performance. Assuming a time-dependent outgassing rate from vacuum chamber walls, equations are offered for predicting progression of evacuation and base pressure distribution throughout the system. Results from small-scale experimental systems are reported and compared with predicted performance. Influence of various pumping systems on prediction is discussed, and design recommendations are offered. (auth)

27029 CERN: FUTURE PROGRAMS. Atoomenergie Haar Toepassingen, 7: 33-4(Feb. 1965). (In Dutch)

The future programs at CERN with respect to installation improvements, storage rings, and the proton synchrotron are briefly indicated. (J.S.R.)

27030 NUMERICAL RESULTS CONCERNING THE CHARGED WAVE GUIDES WITH RECTANGULAR CROSS SECTION. Georges Cornet and Gaston Raoult (Faculte des Sciences, Clermont-Ferrand, France). Compt. Rend., 260: 2447-9(Mar. 1, 1965). (In French)

The theoretical expression of the equation of the dispersion of electromagnetic waves in charged guides with rectangular cross sections was given under the form of an infinite determinant. The numerical exploitation of such an equation and its comparison with the experimental results were reported. (tr-auth)

27031 ON THE FOCUSING OF THE ION BEAM IN A 1-Mev CYCLOTRON. Nyong D. Kwon, Y. N. Lie, and J. S. Chang. New Phys. (Korea), 4: No. 1, 34-6(1964). (In Korean)

The characteristics of electric and magnetic focusing, to increase beam currents effectively, are discussed. A single dee, fan-shaped with a subtended angle 135° or a semicircle, was installed with the addition of a dummy dee. To study the focusing actions the variation of the beam currents with respect to the radius and the distribution of the beam current density to the vertical direction were measured at various distances from the center. The attenuation of the beam currents was decreased almost exponentially, and in the case of the fan-shaped dee, the rate of attenuation was much smaller than for the semicircle, with the addition of the dummy dee the electric focusing was effective at a smaller radius. It was found that the beam width decreased up to a radius 7 cm and increased again in the periphery region. (auth)

27032 A SOURCE OF He^{++} IONS FOR A VAN DE GRAAFF ACCELERATOR. I. J. Taylor and J. L. Weil (Rice Univ., Houston, Tex.). Nucl. Instr. Methods, 34: 197-201(May 1965). (TID-21375)

An ion source for the production of well-collimated beams of doubly charged helium ions was constructed and tested. It consists of an Einzel lens to maintain a well focused beam and a crossed field analyzer so that only one component of the beam will leave the source assembly. Beam currents of 2 μamp of analyzed $^4He^{2+}$ ions are obtainable from the source assembly and up to 0.25 μamp of $^4He^{2+}$ beam was obtained at the entrance to the beam tubes after acceleration in a Van de Graaff generator and after momentum analysis. The source can also be used with H^+, D^+, and He^+ ions. (auth)

27033 AUTOMATIC DATA RECORDING STATION FOR THE TANDEM VAN DE GRAAFF AT ARGONNE. R. J. Pecina and F. J. Spokas (Argonne National Lab., Ill.). Nucl. Instr. Methods, 34: 245-9(May 1965).

One of the data handling stations for the Tandem Van de Graaff is described. Multiplexing techniques are used to record data from a group of multichannel analyzers. Data accumulated from four different types of multichannel analyzers is transferred to punched cards by using an IBM 1622 high speed card reader-punch. Readout of a four hundred channel analyzer is completed in less than twenty sec. A digital plotter and control unit connected to the 1622 reader section allow for immediate plotting of the recorded data. (auth)

27034 A POSSIBLE APPARATUS FOR ELECTRON CLASHING-BEAM EXPERIMENTS. M. Tigner (Cornell Univ., Ithaca, N. Y.). Nuovo Cimento (10), 37: 1228-31 (June 1, 1965).

Apparatus for performing electron clashing-beam experiments with standard traveling wave linacs is discussed. Two linacs having energy gains of 500 Mev each and producing continuous beam currents of 50 to 100 mamp are considered. Several beam layouts are described. (C.E.S.)

27035 CERTAIN PROBLEMS OF PERIODIC ELECTROSTATIC FOCUSING OF SOLID ELECTRON FLUXES. I. A. Danovich. Radiotekhn. i Elektron., 10: 435-42(Mar. 1965). (In Russian)

Calculations were made for periodic electrostatic focusing of electron fluxes. The conditions for minimum oscillation of the focused current were established. The conditions for entrance of the beam into a periodic field were investigated. Some problems, connected with the periodic electrostatic system applied in the SVCH device, were considered. (tr-auth)

27036 POSSIBILITY OF ACCELERATING PARTICLES IN A SECTION WITH $\beta_v = 1$ WITHOUT PRIOR BUNCHING AND WITHOUT A LONGITUDINAL MAGNETIC FIELD. V. I. Koroza and A. V. Shal'nov (Inst. of Physics and Chemistry, Moscow). Uskoriteli, No. 6, 17-20(1964). (In Russian)

The motion of particles in a radial direction in an accelerator at unity relative wave velocity without a longitudinal magnetic field was considered. The spatial motion of the electrons was modeled with an analog computer. The following conclusions are drawn: sections with unity relative wave velocity can be used to accelerate electrons without preliminary bunching and focusing by a longitudinal magnetic field. An increase in the injection energy in the absence of a focusing magnetic field leads to a decrease in the beam broadening. An increase in the electric field intensity leads to broadening of the beam. (ATD)

27037 DYNAMICS OF PARTICLES IN A CYLINDRICAL CAVITY OPERATING AT THE E_{010} MODE. V. K. Baev and V. F. Gass (Inst. of Physics and Chemistry, Moscow). Uskoriteli, No. 6, 43-50(1964). (In Russian)

The dynamics of longitudinal particle motion in a round cylindrical cavity operating in the E_{010} mode are calculated using a combination of analytic and graphical methods. The electron kinetic energy is determined analytically as a first integral of electron motion, and families of curves are plotted with which to determine the phase-energy relations and the energy spectrum of the electron beam at the output of single cavities and of several cavities in cascade, as functions of the cavity length, the field intensity, and the frequency of the electromagnetic field. A numerical example illustrating the application of the method shows that a monoenergetic electron bunch with phase dimension of 110° can be accelerated with the aid of a system of three cavities from 50 kev to 1 Mev, thereby reducing its phase dimension to less than 10° and retaining its monoenergetic character. (ATD)

27038 SEPARATION OF HIGH-ENERGY PARTICLES WITH THE AID OF A LONGITUDINAL ELECTRICAL WAVE. A. A. Glazkov and A. V. Gryzlov (Inst. of Physics and Chemistry, Moscow). Uskoriteli, No. 6, 71-90(1964). (In Russian)

The feasibility of a separator using a diaphragmed waveguide with type E_{01} traveling wave is considered. The initial momentum of the accelerated particle is assumed to be 5 Bev/c. The waveguide separator with longitudinal electric field imparts each particle a small momentum increment, which differs with the type of particle, after which the particles are separated in space by deflection in a static magnetic field. The geometry of the diaphragmed-waveguide cells is chosen such as to ensure synchronous motion of the E_{01} wave and of the particles (wave phase velocity equal to unity). Such a separator does not differ in principle from the well known linear traveling-wave accelerator. However, whereas in an accelerator the tendency is to attain maximum electron energy, in a separator the problem is to have at least one type of particles acquire a momentum increment (positive or negative) which is different to a maximum degree from those of the others. Separators consisting of one section and of two sections are considered and the momentum differences are calculated for three types of particles (antiprotons, pions, and kaons). The results of the calculations show that installations are feasible for the separation of pions and koans, with momentum differences up to 75–100 Mev/c, and with separator lengths 14–22 m. Use of a drift space between two separator sections improves the separation and increases the momentum difference for antiprotons to 100 Mev/c and more. Such separators can be fed from two 20 Mw klystrons operating at approximately 10 cm wavelength. The procedure developed can be used to analyze separators of greater length and with a large number of klystrons, so as to increase further the particle separation. (ATD)

27039 CHARACTERISTICS OF ION SOURCE WITH ELECTRONS OSCILLATING IN A MAGNETIC FIELD. I. G. Morozova (Inst. of Physics and Chemistry, Moscow). Uskoriteli, No. 6, 105-11(1964). (In Russian)

To ascertain the possibility of obtaining maximum ion current, the beam ion current was plotted against the discharge current, the working-gas pressure, the magnetic induction in the ionization chamber, and against the extraction voltage. The results show that the ion current is very sensitive to the discharge current, and it is desirable to operate at larger discharge currents (about 40 mamp) in the ionization chamber. An increase in the magnetic field does not influence the rate of increase of the beam current, but exerts a noticeable influence on its magnitude. Maximum ion current is obtained at small values of magnetic induction, and with increasing magnetic induction the beam current decreases in spite of an increase in the discharge current. In the case of large magnetic fields (0.104–0.155 Tesla), the ion current rises and goes through a maximum with increasing discharge voltage. For small magnetic fields (0.02 Tesla) the ion current of the beam increases with increasing discharge current. The pressure dependence of the ion current depends on the magnetic field, and with decreasing magnetic field the maximum on each ion-current vs. pressure curve it shifts towards higher pressures with decreasing magnetic field. A monotonic increase of the ion current with increasing extracting voltage was observed. The results have shown that the ion current exhibits a complicated dependence on the discharge conditions in the ionization chamber. It is reported that an economic mode with continuous beam current exceeding 100 mamp could be obtained, with a maximum proton energy of 10 kev. It can be increased by increasing the voltage between the housing of the source and the collector. The best operating conditions from the point of view of obtaining maximum beam currents are at pressures on the order of 10^{-2} mm Hg, at a gas flow 10–15 cm^3-norm/hr. To obtain large ion currents it is apparently advantageous to operate at low magnetic inductions at appreciable voltages and pressures in the ionization chamber, and also at large values of the ion-extraction voltage. (ATD)

27040 FOCUSING OF BROAD BEAMS IN THE FIELDS OF ELECTROSTATIC CYLINDRICAL LENSES AND TRANSAXIAL SYSTEMS. A. M. Strashkevich (Kiev Polytechnic Inst.). Zh. Tekhn. Fiz., 35: 177-83(Feb. 1965). (In Russian)

The third order aberrations of a cylindrical electrostatic lens and of a transaxial system are calculated, using nonrelativistic trajectory equations. It is shown that spherical aberration of a cylindrical lens is necessarily present only for the central portion of the image; spherical aberration can vanish in the outer regions of the image. Aberrational blurring in the direction parallel to the generators of the cylindrical equipotential surface is considered. The formulas obtained for the aberrations of cylindrical lenses and transaxial systems contain terms that are corrections for finite beam width to the formulas of Strashkevich and Shtepa for the case of a plane beam. It is shown that the aberrations of a transaxial system are asymptotic to those of a cylindrical lens at large distances from the axis. (ATD)

27041 EFFECT OF SPACE CHARGE ON A KLYSTRON-TYPE BUNCHER. B. A. Snedkov (Inst. of Power Engineering, Moscow). Zh. Tekhn. Fiz., 35: 282-9(Feb. 1965). (In Russian)

The effect of space charge on the bunching action of a resonant cavity is discussed in detail. The electrodynamic approach of Zhileyko is employed, but particular attention is given to graphical methods of calculation useful in practical solution of design problems. The space charge leads to a decrease of equivalent bunching factor, enchanced nonlinearity of the phase-amplitude diagram, a decrease of the equivalent modulation amplitude, and an increase in the length of the bunches. These effects are discussed in detail and are illustrated graphically. There is a brief comparison with results of Weber, who neglected energy spread. Some agreement is found, but the validity of Weber's phase-amplitude diagrams and his method of constructing them are questioned. (ATD)

27042 PRODUCTION OF SHORT ELECTRON BUNCHES IN A LINEAR ACCELERATOR. E. K. Ostrovskii. Zh. Tekhn. Fiz., 35: 290-2(Feb. 1965). (In Russian)

The phase length of a relativistic electron beam of several Mev formed in an injector is shortened using an accelerating system with a phase velocity equal to the velocity of light. Bunches of several tens of degrees from an injector are injected into the accelerating system and distributed symmetrically with regard to the phase $\phi_0 = \pi/2$. The clustering causes an energy spread which, like the degree of clustering, depends on the energy of the clustered particles and the phase length of a bunch at the entrance. The dependences of the phase length of a clustered bunch and of the maximum energy spread on the length at the entrance are obtained for bunch injection energies of 2.5, 3.5, and 4.5 Mev. These dependences make it possible to evaluate the necessary entrance conditions for obtaining a bunch of given phase length if the admissible absolute energy spread at the exit from a clusterer is known. The energy spread limits the application of this method to accelerators where a monoenergetic beam is required, although it can be a reliable means for obtaining short bunches in high-energy accelerators and in cases where the energy spread is not important. (ATD)

27043 INFLUENCE OF BEAM LOADING ON THE SHUNT RESISTANCE OF THE ACCELERATING SYSTEM OF A CYCLIC ELECTRON ACCELERATOR. A. N. Didenko and G. P. Fomenko. Zh. Tekhn. Fiz., 35: 293-7(Feb. 1965). (In Russian)

The influence of beam loading on the operation of a cylindrical resonant electron accelerator is discussed theoretically. The electron beam is assumed to be bunched and the bunches to have negligible dimensions. The field induced by the beam is calculated by expanding in normal modes of the accelerator cavity, and an expression is derived for the energy lost by the beam to this field. The Q of the accelerator cavity is expressed in terms of an equivalent shunt resistance, and a formula is derived for the voltage in the accelerating gap in terms of this shunt resistance, the power applied, and the characteristics of the beam. It is found that for given power and beam characteristics there is an optimum equivalent shunt resistance that produces maximum acceleration. The results are illustrated by calculations relating to the Cambridge Electron Accelerator. It is found that with a power of 300 kw and a bunch size of 2.8×10^8 particles the optimum equivalent shunt resistance is 300 megohm. The actual equivalent shunt resistance of 120 megohm would be optimal if the bunch size were 4.8×10^8 particles. (ATD)

27044 CHERENKOV RADIATION DUE TO THE MOTION OF A PARTICLE IN A CYLINDRICAL RESONATOR LOCATED IN A FOCUSING MAGNETIC FIELD. V. P. Grigor'ev and A. N. Didenko. Zh. Tekhn. Fiz., 35: 298-305(Feb. 1965). (In Russian)

Calculations are made of the radiation of a charged particle moving within a cylindrical resonator located in a focusing magnetic field and executing radial and axial oscillations about an equilibrium circular orbit. The calculation is performed by expanding the field of the moving particle in normal modes of the resonator, retaining only zeroth and first order terms in the ratio of the amplitude of the radial or axial oscillations to the radius of the equilibrium circular orbit, and computing the reaction of the field on the particle. It is found that radiation occurs not only at harmonics of the orbital frequency of the particle but also at linear combinations of these with harmonics of the radial and axial oscillation frequencies. Separate formulas are derived for the power radiated in E and H waves. Several limiting cases are discussed, and for a resonator of infinite radius the formula of Nodvik and Saxon for the radiation of an electron moving between infinite plane-parallel conducting planes is rederived. Radiation does not occur when the radius of the resonator is small compared with the wavelength. (ATD)

27045 PULSE CHARACTERISTICS OF MODIFIED PENNING TUBES. Yu. E. Kreindel and E. N. Fakhrutdinov (Tomsk Inst. of Radio Engineering and Electronics, USSR). Zh. Tekhn. Fiz., 35: 312-14(Feb. 1965). (In Russian)

Penning discharges in air were investigated under conditions such that neither the electric nor the magnetic field possessed axial symmetry. A cross section of the discharge tube is shown. The permanent magnet produced a field of 350 Oe in the 13-mm gap between the 20-mm diameter cathodes. The 18-mm diameter cylindrical anode was provided with a 6-mm diameter opening through which electrons passed and were caught in the Faraday cup. The tube was operated with 10 μsec pulses with a repetition rate of 50 sec^{-1}, and the anode potential, the anode current, and the current to the Faraday cup were displayed on oscilloscopes. The current pulse to the Faraday cup was always somewhat delayed with respect to the anode current pulse, and was of shorter duration. The current to the Faraday cup was not strongly dependent on the anode potential and under optimum conditions amounted to 0.85 of the total discharge current. The spread of the beam issuing from the anode opening was estimated by observing the decrease in the Faraday cup current with increasing distance between the cup and the discharge tube. The beam spread decreased somewhat as the pressure was increased from 0.004 to 0.007 mm Hg, indicating the operation of ionic focusing. (ATD)

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Refer also to abstracts 26747 and 27347.

27046 (UCRL-7820(Rev.1) and (Suppl.)) CALCULATION OF STELLAR STRUCTURE USING AN IONIZATION EQUILIBRIUM EQUATION OF STATE. Carl A. Rouse (Lawrence Radiation Lab., Univ. of California, Livermore). July 20, 1964 and Jan. 7, 1965. Contract W-7405-eng-48. 41p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

An ionization equilibrium equation of state (IEEOS) is used in explicit difference equations describing the equilibrium of a self-gravitating, non-rotating gaseous sphere. Applied to the solar problem, this method has accomplished the first known continuous calculation of the sun's mass, radius, luminosity, and structure of the photosphere interior to the 5800°K radius. It was necessary to include a varying helium abundance before the solar radius could be calculated. A photospheric H/He ratio of 20 is shown to be compatible with a central temperature, T_c, of about 19.5×10^6°K and a central density, ρ_c, of about 36 g/cc; whereas a H/He ratio of 5.55 is compatible with a T_c of about 21×10^6°K and ρ_c of about 30 g/cc. A significantly different abundance of carbon-nitrogen than usually given for the core would alter the indicated values of T_c and ρ_c. The ability to calculate the structure of the photosphere between optical depths of 0.5 and 2 in calculations from the center is demonstrated, hence the establishment of a good H/He ratio as well as variations of temperature and electron pressure in the visible portion of the photosphere would help to establish the interior structure of the sun. The calculated mass and radius are shown to depend on the high density formulation of the IEEOS. Stability criteria are presented which are based upon changes in the effective gamma and the mean molecular weight that are different from the corresponding changes along the equilibrium profile. The consequences are compatible with the possibility that perturbations of the right strength in different regions could lead to granulation, prominences, or matter ejected that is hot enough to help account for the high temperature and irregular nature of the corona. (auth)

27047 SOLAR MAGNETIC FIELD FROM BABCOCK'S THEORY OF SOLAR ACTIVITY. E. Chvojkova (Inst. of Astronomy, Czechoslovak Academy of Sciences, Prague). Bull. Astron. Inst. Czech., 16: 57-63(1965).

Babcock applied his theory of solar activity merely to the equatorial sunspot zone up to the latitude $\varphi = 30°$. In spite of the complexity of the problem outside 30°, an attempt was made to extend the investigation beyond this limit, taking into account the dipolar magnetic field and anticipating that

in the subsurface zone the levels of equal angular rotation are planes perpendicular to the axis of rotation. A comparison with Babcock's model led to the following conclusions: Babcock's derivation of Spörrer's law reproduces the real state most accurately. This means that up to about 25 or 30°, the magnetic field lines of the whole dipole are perhaps concentrated in the relatively shallow surface layer without traversing the surface, while in the polar cap—up to about 60°—the dipolar magnetic field is not much affected. The transition zone between 30 and 60° remains the most interesting. There exists there a latitude φ_x (or φ_y) separating the equatorial sunspot zone from the polar active zone (where probably no sunspots will appear). Magnetic field lines there traverse the surface lying in the level of equal rotation, so that they are unaffected by the differential rotation. Thus, sunspots can never appear at this latitude since no amplification of the field lines sets in. The formula is also obtained, explaining why sunspots beyond 30° drift to higher latitudes up to φ_x. It is also not without interest that even the dipolar model agrees well with reality when levels of equal angular velocity are anticipated not quite perpendicular to the axis of rotation but somewhat bent towards the solar center. (auth)

27048 MAGNETIC FIELD AND ERUPTIVE SOLAR PROMINENCES. E. Chvojkova and J. Klepesta (Inst. of Astronomy, Czechoslovak Academy of Sciences, Prague). Bull. Astron. Inst. Czech., 16: 70-3(1965).

In a gravity field, charged particles spiral along dipolar magnetic lines between two reflecting levels. When the particle moves with a velocity exceeding the escape velocity v_{esc}, there exists only the lower level of reflection, the well-known magnetic mirror. When the velocity at one reflecting level approaches the critical velocity $v_W \approx v_{esc}/3^{0.5}$ the other reflecting level approaches the first one; and at $v = v_W$, the two coincide. In spite of the fact that the particle velocity is extremely high there, the particle is prevented from drifting along the field line; it becomes "frozen" in the given point of the field line circling with nearly escape velocity. Particles with somewhat different velocity or direction, which pass through the frozen zone, are somewhat decelerated too, thus producing the plasma bunches often observed which move along the field lines with a velocity much below the particle velocity. When an intense plasma stream, ejected from the photosphere with about the escape velocity, is slowed down by the surrounding plasma up to the mean velocity v_W some particles become frozen thus providing the best conditions for large condensation. When particles are reflected with the velocity close to v_W the two reflecting levels are already so near that the particles are trapped between them and neither reach the surface nor escape; often, they can not reach even the top of the magnetic loop. Thus, besides the origin of plasma bunches, the formulas can perhaps explain some interesting features of solar prominences, such as suspending clouds, quiet filaments, and the origin of the high speed of their bursts. (auth)

27049 SOME CALCULATIONS OF THE THERMAL HISTORY OF MARS AND THE MOON. S. V. Maeva (Inst. of Physics and Tech., Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 159: 294-7(Nov. 11, 1964). (In Russian)

Heat transfer calculations on the heating up and melting of the internal portions of Mars and the Moon due to radiogenic heating were carried out on a digital computer. The potassium content was taken as 0.08×10^{-2} g/g, and the U content varied from 1 to 3×10^{-6} g/g. The Th content was four times the U content. The increase in density, ρ, was assumed to follow the rule: $\rho(r) = 4.40 - 0.702\ (r/R)^2$, where R is the radius of the planet. The age of Mars is 4.5×10^9 yrs, and the heating-up process was assumed to start at 0.2×10^9 and at 0.4×10^9 years after the formation of Mars. The heat capacity c was taken as 0.25 cal/g deg, which was corrected for the temperature variation with depth. The mineral at the center was assumed to melt at 2470°K, or at 3260°K. The thermal conductivity, λ, was taken as 1.2×10^{-2} cal/cm deg sec, and was corrected to include a radiative term at the highest temperature. The calculations show that Mars became molten at a depth of 400 to 700 km 1.7 to 2.5×10^9 years after its formation (depending on the content of U and Th). The surface heat flux of Mars is now 0.28 to 0.41×10^{-6} cal/cm^2 sec. The heat flux of the moon varies from 0.23 to 0.46×10^{-6} cal/cm^2 sec. At present the moon is solid to a depth of 500 to 800 km (60 to 80% of its volume), and the center of the moon is partially melted. (TTT)

27050 OBSERVATION OF WEAK DISTURBANCES OF SOLAR RADIO EMISSION IN YEARS OF MINIMUM SOLAR ACTIVITY BY THE "QUASI-ZERO" METHOD. M. S. Durasova, G. A. Lavrinov, V. M. Shumkina, and O. I. Yudin (Gorkii State Univ., USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 728-9(1964).

Weak disturbances of the radio flux from the sun were recorded using the "quasi-zero" method in which the signal from the sun, arriving at the input of a Dicke radiometer, is balanced by the signal from a noise generator, which is connected to the second arm of the modulator. (D.C.W.)

27051 URANIUM AND THORIUM IN THE NUEVO LAREDO ACHONDRITE. J. W. Morgan and J. F. Lovering (Australian National Univ., Canberra). J. Geophys. Res., 70: 2002(Apr. 15, 1965).

Final values for U and Th in the Nuevo Laredo achondrite are presented. These values are significantly different from preliminary ones and agree with previous determinations. (M.H.R.)

27052 HYDROMAGNETIC EQUILIBRIUM AND TOROIDAL (RING) CURRENT SYSTEMS. Marvin L. White (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 70: 2159-70(May 1, 1965).

A self-consistent steady-state treatment is given for the interaction of an inexorable radial source of completely ionized hydrogen with a poloidal magnetic field. When the particles are directed radially outward (inward) the magnetic lines of force are weakened (strengthened) with increasing particle emission (injection). The poloidal magnetic field is generally expressible in terms of the undisturbed component (solutions of Laplace's equation) times a MHD distortion factor given by the confluent hypergeometric functions. Expressions are given for the toroidal current and current density associated with the distorted field and for the particle flux required to maximize the total toroidal current. Coronal azimuthal (ring) current densities comparable to ionospheric current densities are predicted. (auth)

27053 LOCAL THERMODYNAMICS AND THE UNIVERSE. W. Davidson (Battersea Coll. of Tech., London). Nature, 206: 249-51(Apr. 17, 1965).

It is shown that the radiation density in the universe can be obtained merely by integrating the local equation expressing the first law of thermodynamics for cosmic radiation. (D.C.W.)

27054 FURTHER SOFT X-RAY IMAGES OF THE SUN. P. C. Russell (Univ. of Leicester, Eng.). Nature, 206: 281-2(Apr. 17, 1965).

Part of the negative of the soft x-ray image of the Sun that was obtained on Dec. 17, 1964, by the Skylark research rocket is reproduced. The presence of limb brightening is clearly evident. (P.C.H.)

27055 ORIGIN OF THE ELEMENTS. Bernard Pagel. New Scientist, 26: 103-7(Apr. 8, 1965).

Some current theories of the formation of the elements heavier than hydrogen are outlined, with consideration of their merits and objectionable features. Nuclear processes in stellar evolution are considered in some detail. (D.C.W.)

27056 ROTATION AND GRAVITATIONAL COLLAPSE. R. V. Wagoner (Stanford Univ., Calif.). Phys. Rev., 138: B1583-?(June 21, 1965).

A new method of solution of the Einstein field equations is used to investigate the gravitational collapse of a rotating massive body. The equations are studied on a timelike hyperplane of reflection symmetry within an axially symmetric distribution of perfect fluid. The assumptions of

negligible pressure and uniform angular velocity in the hyperplane, as well as certain restrictions on the development of the metric off the hyperplane, allow the metric to be reduced to a simple form. An explicit family of solutions is obtained for the evolution in time of the metric at a fixed radius in a comoving coordinate system. These solutions contain as limiting cases, valid throughout the hyperplane, the nonrotating collapse of a uniform-density sphere and the Newtonian equation of motion for a class of finite rotating bodies. The general solution reveals that rotation is unable to halt gravitational collapse at a given comoving radius if the ratio of rest mass interior to that radius to angular momentum per unit mass at that radius is sufficiently large. In that case the contribution of the rotational kinetic energy to the effective gravitational mass becomes more important than the opposing effect of centrifugal force. This leads to a dynamical singularity, in which the proper-time derivatives of both radial and circumferential distances become negatively infinite, while the distances themselves remain finite. (auth)

27057 GAMMA- AND X-RAY ASTRONOMY. V. L. Ginzburg and S. I. Syrovatskii. Priroda, No. 3, 50-8(Mar. 1965). (In Russian)

A brief comparison is made of the γ- and x-ray properties and new γ- and x-ray methods in astronomy are discussed. (R.V.J.)

27058 ON THE ROUTE FROM EARTH TO MOON. THE RADIATION DANGER OF SPACE FLIGHTS, AS ESTIMATED BY BIOLOGISTS. V. V. Antipov, M. D. Nikitin, and P. P. Saksonov. Priroda, No. 4, 46-53(Apr. 1965). (In Russian)

A general evaluation was made of the radiation environment near the Earth and of the ionizing radiation effects during the space flight to the Moon. The physical characteristics of the principal type of cosmic radiation were reviewed, and biological doses of primary cosmic radiation were determined to be 10 Rem during two-weeks flight behind the protection of shielding of 1 to 2 g/cm^2. It is stressed that protons produced by solar bursts are of the greatest danger to the astronaut and the shielding thickness of 3 g/cm^2 may reduce the integral dose to the permissible level of 25 Rem. (R.V.J.)

27059 THE INTERPRETATION OF THE XUV SOLAR SPECTRUM. C. W. Allen (London Univ.). Space Sci. Rev., 4: 91-122(Feb. 1965).

The earth's ionosphere and the solar atmosphere are reviewed, in relation to the recent observations of solar xuv (soft x radiation and for u-v radiation). The expected ionospheric characteristics are derived as directly as possible from the xuv observations and then compared with the well-known D-, E-, and F-layer formations. The comparison leads to a high ionospheric recombination coefficient decreasing rapidly with height, contributions to the E-layer from both uv and x-rays, and very little difference in the solar cycle variations from the D-, E-, and F-layers, although intensity variations are greater from high than low ions. The flux measurements of the identified xuv solar emission lines give information on the numbers of ions in the solar atmosphere. This makes it possible to derive the amount of solar material in each temperature range, the chemical abundances, and the physical differences between quiet solar atmosphere, centers of activity, and flares. When the new dielectronic recombination coefficients are well investigated, it should be possible to redetermine the distribution of solar material with temperature. The fitting of such results to chromospheric and coronal models provides many problems. 106 references. (auth)

27060 AMPLIFICATION OF MAGNETIC FIELDS WITHIN SUNSPOT GROUPS. Jaakko Tuominen. Z. Astrophys., 60: 231-9(1965).

It is shown that large horizontal whirls connected with the differential rotation may be created in the photospheric and subphotospheric layers of the sun. These whirls explain the observed high magnetic fields of bipolar magnetic regions and bipolar sunspot groups; the fact that, as a rule, the preceding spot is nearer to the equator than the following; and the observed motions of the components of bipolar groups. (auth)

27061 THE EFFECTS OF RADIATIVE BRAKING ON FREE PERIODS OF STELLAR PULSATIONS. Zdenek Kopal (Boeing Scientific Research Labs., Seattle). Z. Astrophys., 61: 156-64(1965).

The virial theorem generalized to include the effects of interaction of matter with radiation in stellar interiors is invoked to evaluate the influence of such effects on the fundamental mode of free periods of radial oscillations. Two types of solution are considered in some detail: one of purely harmonic oscillations with phase-lag; the other oscillating in phase throughout the interior, but with complex frequency. It is shown that, in both cases, the interaction terms in the virial theorem introduce the luminosity L of the respective configuration explicitly in the equation for the period, in such a manner as to make the latter increase with L. The quantitative effects of such influence are found to be negligible for configurations of moderate density concentration, and could become appreciable only if this concentration were to become very high. Moreover, the fact that the real part of complex frequency turns out to be positive opens a possibility for the outward flux of radiation to feed energy into radial oscillations of the stars to give them a start if (and only if) the central condensation of such a configuration is sufficiently high. (auth)

Atomic Physics

Refer also to abstract 26789.

27062 (CEAL-1017) ON SYNCHROTRON RADIATION PRODUCED PHOTO-ELECTRONS FROM COPPER. G. E. Fischer and R. A. Mack (Cambridge Electron Accelerator, Mass.). Feb. 28, 1965. Contract AT-30-1-2076. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The absolute quantum efficiency of photoelectron production from copper was measured in a hitherto inaccessible photon energy region using the broad spectrum of polarized synchrotron radiation from the Cambridge Electron Accelerator. The results, believed accurate to within ±10%, have application in the design of vacuum systems and beam current monitors for high current storage rings. The measurements were carried out under ultra-high vacuum conditions. Energy distributions of electrons resulting from photon spectra of various characteristic energies are presented. In the regions of photon energy below 50 ev and above 1 kev where data of previous investigators exist qualitative agreement of yield and angular dependence is found. (auth)

27063 (INR-555/XIV) OXIDE PHASES OF NIOBIUM OCCURRING UNDER IONIC BOMBARDMENT. B. Bochenek, M. Fiett, and E. Mizera (Institute of Nuclear Research, Warsaw (Poland)). Oct. 1964. 31p. Dep.

Metallic and oxide phases of Nb obtained by ionic bombardment in a glow discharge were investigated. Oxygen with nitrogen, oxygen with argon, and pure oxygen under pressures of 10^{-2} to 10^{-3} mm Hg in the cathodic etching apparatus were used. Results from metallographic and x-ray studies show relatively strong lattice parameter increases of the metallic phase and prove the existence of NbO_2 and NbO oxide phases. Depending upon the bombardment conditions, another niobium oxide, such as NbO_2, possibly exists. (auth)

27064 (LA-3147-MS) MEASUREMENTS OF THE ABSOLUTE FLUORESCENCE EFFICIENCY OF AIR UNDER ELECTRON BOMBARDMENT. Paul L. Hartman (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Jan. 1964. Contract W-7405-eng-36. 54p. Dep.; $3.00(cy), 2(mn) CFSTI.

Air at pressures between 10^{-1} and 10^{-2} mm Hg is excited by controlled electron beams of energies up to 1 kev. The light output is sampled as regards both geometry and spectrum, so that the total amount of light emitted and the fluorescence efficiency can be determined. The emission of the 3914-Å (0,0) band of N_2^+ is considered. Integration

was done by three independent methods: by using an optical integrating sphere in which the electron energy is deposited, by sweeping a scanning detector around the glow, and by sampling the glow produced in a transparent bell jar. Calibrations are described in some detail. The perturbing effects of very slow electrons are described. The preliminary results are $\eta_{total} = 1.8\%$, from 3000 to 11,000 Å and $\eta_{3914} = 0.33\%$. (auth)

27065 (ORNL-P-116) LASER OSCILLATION IN He–Ne AT 3.3902 μ. H. W. Morgan, P. A. Staats, and P. M. Griffin, K. L. Vander Sluis, and G. K. Werner (Oak Ridge National Lab., Tenn.). [1963]. Contract [W-7405-eng-26]. 3p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The existence of a weaker laser radiation at 3.3902 μ alongside the 3.3913 μ laser in He–Ne discharges is pointed out. The weaker emission may exhibit as much as 0.3 the intensity of the 3.3913 μ emission. Both emissions oscillate over the range 1.3 to 0.6 torr with He–Ne ratios from 10:1 to 2:1. By using sufficient attenuation in the cavity, the 3.3902 μ emission can be suppressed. (D.L.C.)

27066 (SC-RR-65-77) ON THE $^2\Sigma_g^+$ AND $^2\Sigma_u^+$ STATES OF THE HYDROGEN MOLECULE ION. James M. Peek (Sandia Lab., Albuquerque, N. Mex.). Apr. 1965. Contract AT(29-1)-789. 44p. Dep.; $3.00(CFSTI).

The eigenparameters for H_2^+ are calculated for the $1s\sigma_g$-$^2\Sigma_g^+$ and $2p\sigma_u$ $^2\Sigma_u^+$ states of H_2^+ over the range of internuclear separations $R = 0.1(0.01)1.00(0.05)30.0a_0$. The screening parameters and energies for the LCAO (linear combination of atomic orbitals) approximation to these same two states are calculated for $R = 0.05(0.05)20.0a_0$. The dipole matrix element is calculated for $R \leq 9.0a_0$ in the LCAO approximation and also with approximate functions used for these states by Cohen, Judd, and Riddell. The resulting energies and dipole matrix elements calculated with these approximate functions are compared with the calculations based on the H_2^+ eigenfunctions. (auth)

27067 THEORY OF MESIC ATOMS. N. J. Ionesco-Pallas (Institut de Physique Atomique, Bucharest). Ann. Physik (7), 15: 144-9(1965).

The Klein-Gordon and Dirac equations are solved for the case of a potential yielded by a constant charge distribution inside the nucleus. By an iterative process, the resulting formulas provide an unrestricted accuracy. The approximative expressions of the energy, valid for light mesic atoms, are discussed. The method used consists in perturbing the boundary conditions. (auth)

27068 THE THEORY OF IONIZATION ENERGY LOSSES IN THIN FILMS. G. M. Garibyan and M. P. Lorikyan (Inst. of Physics, Erivan). Dokl. Akad. Nauk Arm. SSR, 40: 21-4(1965). (In Russian)

Ionization energy losses of a charged particle passing with velocity v through a plate with stationary dielectric constant ϵ_0, placed in a vacuum, are considered. The losses due to the action of the particle's electromagnetic field are modified, in the density effect, by the action of electromagnetic radiation fields in the regions in front of, within, and after the plate. Differential equations for the losses are given, and integration is carried out for the cases of the absence and occurrence of the density effect, when $v^2 < c^2/\epsilon_0$ and $v^2 > c^2/\epsilon_0$, respectively. The conditions under which the plate may be considered thin are derived. (M.J.T.)

27069 REFLECTION OF MONOENERGETIC ELECTRONS RANGING WITHIN 600 TO 1200 kev FROM CERTAIN METALS AND FROM GRAPHITE. P. Ya. Glazunov and V. G. Guglya (Inst. of Physical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 159: 632-5 (Nov. 21, 1964). (In Russian)

Samples of Pb, Sn, Zn, Al, and C were mounted in a vacuum chamber and hit with a collimated beam of monoenergetic electrons ($\Delta E/E < 1\%$). The diameter of the sample was 55 mm, and the thickness exceeded the total absorption thickness of the electrons. The samples were ground flat, but not polished. An aluminum collector was used to determine the backscattered electrons, and the coefficient of reflection was taken as the ratio of the collector current to the primary current: $\eta = I_{col}/(I_{sam} + I_{col})$. A potential of −600 to +600 volts could be applied to the collector to eliminate low-energy reflected electrons. It was found that the coefficient of reflection decreases linearly with increasing energy of the primary electron beam. The results are in good agreement with literature data at lower energies of 50 to 350 kev elements, and at a higher energy of 1750 kev electrons. The secondary electron emission coefficient was 3 to 6% for all elements. (TTT)

27070 INTENSITIES OF L X-RAY SPECTRA OF THE LIGHTER ELEMENTS. Ralph W. G. Wyckoff and Franklin D. Davidson (Univ. of Arizona, Tucson). J. Appl. Phys., 36: 1883-5(June 1965).

Relative intensities, as recorded with a flow proportional counter, were measured for the L spectral lines of antimony (n = 51) through chlorine (n = 17). (auth)

27071 WIDTHS OF TRANSMISSION KIKUCHI LINES IN SILICON AND DIAMOND. H. A. Fowler and L. Marton (National Bureau of Standards, Washington, D. C.). J. Appl. Phys., 36: 1986-95(June 1965).

Detailed transmission Kikuchi patterns for silicon and diamond at 80 kev were measured with high angular resolution ($\sim 10^{-4}$ rad). Linewidths of all simple Bragg reflections are consistent with an elastic-scattering model, which uses scattering amplitudes calculated by Ibers in a first Born approximation. Various interferences between strong Bragg reflections were observed. (auth)

27072 IONIZATION OF ATOMS BY COLLISION WITH EXCITED ATOMS. Kanji Katsuura (Northwestern Univ., Evanston, Ill. and Univ. of Notre Dame, Ind.). J. Chem. Phys., 42: 3771-5(June 1, 1965).

Ionization of atoms by collisional transfer of electronic excitation energy, $A^* + B \rightarrow A + B^+ + e$, is considered theoretically. A formula for the cross section was derived for the case where the transition $A \rightarrow A^*$ is optically allowed and the excitation energy of A^* is larger than the ionization potential of B, and was applied to several examples where A^* is He (2^1P). (auth)

27073 MASS-SPECTROMETRIC STUDY OF THE BIMOLECULAR FORMATION OF DIATOMIC ARGON ION. Philip M. Becker and F. W. Lampe (Pennsylvania State Univ., University Park). J. Chem. Phys., 42: 3857-63 (June 1, 1965).

Pulsed mass-spectrometric studies of the bimolecular formation of Ar_2^+ showed that the reaction proceeds via three excited states of argon, which have excitation functions that peak at 18, 28, and 65 ev. In kinetic studies, effective radiative lifetimes and specific reaction rates were determined at these electron energies. The rather large rate constants observed ($1.3-2.0 \times 10^{-9}$ cm^3 molecule^{-1} · sec^{-1}) yielded collision diameters in good agreement with those predicted by simple theoretical considerations of the radii of argon atoms in the $3p^5$ 4d and $3p^4$ 5p configurations, such configurations being of the lowest energy compatible with the smallest reported appearance potential of 14.7 ev for Ar_2^+. (auth)

27074 THEORY OF SLOW ATOMIC COLLISIONS. I. H_2^+. Walter R. Thorson (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 42: 3878-91(June 1, 1965).

A theory of zero-order elastic and first-order inelastic scattering for slow atomic collisions in the system H_2^+ is presented. The method of stationary states and partial wave analysis was used and the treatment meets the formal requirement of scattering theory that the zero-order eigenfunctions become correct eigenfunctions at $R \rightarrow \infty$. The method is applicable only to electronic states that are "tightly bound" ($\gtrsim 0.25$ ev below the ionization limit); no treatment of scattering to "continuum" states of the electron is given. The use of partial wave analysis makes possible the elimination of practical difficulties, which appear in the time-dependent treatments due to nonorthogonality of the electronic basis functions. The zero-order eigenfunctions may properly be termed "adiabatic" solutions, since

they are physically the logical extension of the Born-Oppenheimer concept to unbound states, and for many problems zero-order elastic scattering is just potential scattering by the Born-Oppenheimer potential. First-order inelastic scattering cross sections can be computed from electronic transition matrix elements, which differ in significant respects from those of "perturbed stationary states" method. (auth)

27075 SCATTERING OF H ATOMS BY D_2 MOLECULES. W. L. Fite and R. T. Brackmann (Univ. of Pittsburgh). J. Chem. Phys., 42: 4057-8(June 1, 1965).

In an identical study previously presented (Atomic Collision Processes, pp. 955 to 963) a figure was presented for the differential scattering cross section for nonreactive scattering of a thermal beam of H atoms at approximately 3000°K by a cross beam of D_2 molecules at 77°K. It was found that that curve was subject to a systematic experimental error. A preferred curve is given for this differential cross section, measured in the laboratory coordinates. This increased the reaction differential scattering cross section estimated by nearly a factor of 2. (M.C.G)

27076 SOME FIRST-ORDER PERTURBATION ENERGY VALUES. Frank C. Sanders and Charles W. Scherr (Univ. of Texas, Austin). J. Chem. Phys., 42: 4314(June 15, 1965).

The first-order perturbation energy corrections were calculated for a number of singly excited singlet and triplet states of the helium isoelectronic sequence. (M.C.G.)

27077 PROPOSED THEORY OF CALCULATING THE ENERGY OF NEGATIVE-ION RESONANT ELASTIC SCATTERING STATES AND OF THE PRE-IONIZATION STATES OF ELECTRONIC SPECTROSCOPY. Howard S. Taylor and J. K. Williams (Univ. of Southern California, Los Angeles). J. Chem. Phys., 42: 4063-72(June 15, 1965).

In elastic electron-impact experiments, with the subsequent formation of negative ions and pre-ionization spectral theory, similar theoretical problems arise. In both, autoionizing states of lifetimes from 10^{-14} to 10^{-12} sec were of basic importance, and the variation principle was not applicable to the problem of the calculation of the energy. An approximate variation principle is proposed for calculating their energies and wavefunctions. The ideas are based on physical and nonanalytic arguments and tested successfully on the problem of elastic scattering of electrons by the hydrogen molecule, with an explanation of the H_2^- resonances observed by Simpson et al. and the H^--resonance observed by Schulz. (auth)

27078 CROSS SECTIONS FOR DISSOCIATIVE IONIZATION OF MOLECULES BY ELECTRON IMPACT. Donald Rapp, Paula Englander-Golden, and Donald D. Briglia (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Chem. Phys., 42: 4081-5(June 15, 1965).

Cross sections for dissociative ionization were measured as a function of electron energy from threshold to 1000 ev in nine gases (H_2, D_2, N_2, CO, NO, O_2, CO_2, N_2O, and CH_4) by collecting those ions reaching the ion collector after passing through a 0.25-v retarding potential in a total-ionization tube. Approximate correction was made for the effective solid angle subtended by the ion collector at the electron beam. The results are reported as the fraction of total ionization, and as absolute cross sections for dissociative ionization. At moderately high energies (>70 ev), the fraction of total ionization that is dissociative for ions with kinetic energy in excess of 0.25 ev, ranged from ~7% in H_2 and D_2 to ~35% in N_2O, with other gases intermediate. (auth)

27079 CROSSED-BEAM INVESTIGATION OF N_2D^+ PRODUCTION IN N_2^+-D_2 COLLISIONS. B. R. Turner, M. A. Fineman, and R. F. Stebbings (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Chem. Phys., 42: 4088-96(June 15, 1965).

The reaction $N_2^+ + D_2 \rightarrow N_2D^+ + D$ was studied in a crossed-beam experiment. The angular distribution of the secondary ions was determined with a movable quadrupole mass filter. Differential cross sections were obtained within the energy range from 7.5 to 57.5 ev. Total cross sections for this reaction were determined using another crossed-beam apparatus in which the product ions were collected in toto. Total cross sections were also derived from the angular measurements, but less reliance was placed in these values. (auth)

27080 CALCULATION OF THE TOTAL CROSS SECTION FROM ANGULAR MEASUREMENTS IN CROSSED-BEAM EXPERIMENTS. J. Colwell and M. A. Fineman (General Dynamics Corp., San Diego, Calif.). J. Chem. Phys., 42: 4097-4100(June 15, 1965).

The total cross section is written as the sum of an integral taken over the scattered intensity measured in the plane of the initial velocity vectors and a correction term, which itself is the sum of two integrals of the center-of-mass differential cross section. One of these integrals is taken from 0 to ϵ, the other from π-ϵ to π, where ϵ is the angle between the center-of-mass velocity and the relative velocity. In certain atomic or molecular scattering experiments, the angle ϵ is small; for these cases, it is shown that only a small error is made by dropping this correction term. This error was estimated for the case of isotropic scattering and for the case of glory scattering. In the latter case, the range of parameters for which the method is useful is given. In the event that the shape of the differential cross section is known a priori, the correction term can be calculated and the total cross section found exactly. (auth)

27081 ORBITAL RADII OF ATOMS AND IONS. J. T. Waber and Don T. Cromer (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 42: 4116-23(June 15, 1965). (LA-DC-6940)

Radii corresponding to the principal maxima in the radial distribution functions $r^2\psi_1^2(r)$ were obtained for the ground states of all the atoms in the periodic table. The relativistic wavefunctions employed were solutions of the Dirac equations. Slater's $\rho^{1/3}$ method for including exchange and Latter's method for the self-interaction correction were used in "creating" the potential. The radii corresponding to these maxima were used as measures of the size of each orbital. The relation between the orbital radii of the valence electrons is shown as plots for the first, second, and third series of transition elements. In the elements below nobelium, only four maxima occurred in the total charge-density function. The relation of these maxima to the shell structure of the atom and the effect of shielding by outer electrons are discussed. The effect of the relativistic contraction on orbitals of low angular momentum is shown. (auth)

27082 SPIN HAMILTONIAN FOR A MANY-CENTER IMPERFECTION WITH APPLICATIONS TO THE V_K CENTER. T. N. Casselman and J. J. Markham (IIT Research Inst., Chicago). J. Chem. Phys., 42: 4178-83(June 15, 1965). (TID-21449)

A spin hamiltonian containing the interaction of a one-electron defect center with the surrounding ions was derived. It is shown, by means of the gauge invariance of perturbation theory, that for a many-center imperfection in a magnetic field, a different gauge may be chosen for each force center such that the orbital angular-momentum operators refer to the individual force centers. This result was found to be a consequence of the gauge transformation properties when orbital angular-momentum operators occur in the hamiltonian. The spin hamiltonian was applied to the g shift of the V_K center and some qualitative results were obtained for the case of nonorthogonal atomic orbitals. (auth)

27083 HYPERVIRIAL FUNCTIONS AND THE POSITIVE POWERS OF THE RADIAL COORDINATE OPERATOR IN He AND H^-. Sidney L. Gordon (Georgia Inst. of Tech., Atlanta). J. Chem. Phys., 42: 4184-93(June 15, 1965).

Ground-state He and H^- trial functions were scaled to satisfy the hypervirial relations generated by the family of hypervirial operators $W_n = r_1^n p_1$. These one-parameter

hypervirial functions were used to calculate expectation values of the positive powers of the radial coordinate operators, r^t, for t = 1 through 20. Accurate values of $\langle r^t \rangle$, for this range of t, were calculated using 20-term Hylleraas functions. A comparison of results showed that simple hypervirial functions of the form $\exp[-K(r_1 + r_2)]$ scaled to satisfy the hypervirial relations generated by W_2, give a good over-all calculation of $\langle r^t \rangle$ for both He and H^-. The hypervirial theorem was used to develop a variety of expectation value relationships for one- and two-electron central force problems. (auth)

27084 SINGLE-CONFIGURATION CALCULATIONS ON EXCITED STATES OF HELIUM. [PART] II. Ernest R. Davidson (Univ. of Washington, Seattle). J. Chem. Phys., 42: 4199-4200(June 15, 1965).

The best one-configuration wavefunctions for the first 18 excited states of helium were found. The error in the energy varied from 2% of the ionization energy for the $2s^1S$ state to 0.1% for the $4f^3F$ state. The electron-repulsion integral was consistently larger for triplet states than for singlet states, in contradiction to other theories. (auth)

27085 MAGNETIC PROPERTIES OF THE Li_2 MOLECULE. Richard M. Stevens and William N. Lipscomb (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 42: 4302-4(June 15, 1965).

Results of computations of magnetic properties by the perturbed or coupled Hartree-Fock method are summarized for Li_2. Zero-order basis sets and contributions to the rotational magnetic moment are given. Rotational magnetic moments were calculated to be 0.1101 and 0.1100 nm for two basis sets, in excellent agreement with the experimental value. These sets also yielded values of 0.242 and 0.240 kc/sec for the spin rotational constant of ^7Li, and values of 98.59 and 98.58 ppm for the shielding of lithium. The prediction that in the ionic model the inner shell terms make very little contribution was confirmed. The study also supported the validity of core approximation in calculations relating to the diatomic alkali molecules. (M.C.G.)

27086 HARTREE-FOCK-SLATER WAVEFUNCTIONS AND MAGNETIC PROPERTIES OF RARE-GAS ATOMS. K. M. S. Saxena and P. T. Narasimhan (Indian Inst. of Tech., Kanpur). J. Chem. Phys., 42: 4304-5(June 15, 1965).

The diamagnetic susceptibility and the nuclear magnetic shielding values for all rare gas atoms were calculated, and Hartree-Fock-Slater (HFS) single determinantal wavefunctions were used for testing these values. The values of the one-electron integrals $\langle r^2 \rangle$ and $\langle 1/r \rangle$ for the various atomic orbitals of helium and neon atoms using HFS wavefunctions are given. For heavy atoms the 1s and even 2s orbitals became very much contracted. (M.C.G.)

27087 NEW EQUATION FOR LOWER BOUNDS TO EIGENVALUES WITH APPLICATION TO THE HELIUM ATOM. William H. Miller (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 42: 4305-6(June 15, 1965).

An equation was developed for calculating the lower bounds to the eigenvalues of a hamiltonian. To test the usefulness of the equation, it was applied to the S states of the helium atom. (M.C.G.)

27088 THE PHOTOELECTRIC CROSS SECTIONS OF Sn, Ta AND Au AT 2.62 Mev. Frank Titus (Dartmouth Coll., Hanover, N. H.). Nucl. Phys., 69: 179-85(July 1965).

The photoelectric cross sections of Sn, Ta, and Au at 2.62 Mev were measured in terms of the differential Compton scattering cross section at the same energy. The measured cross sections are (in b) 0.11 ± 0.03, 0.47 ± 0.05, and 0.74 ± 0.06 for Sn, Ta, and Au, respectively. These cross sections are considerably smaller than those tabulated by Grodstein and are somewhat smaller than theoretical cross sections calculated by Pratt. (auth)

27089 MILLIMETER-WAVE MOLECULAR-BEAM SPECTROSCOPY: ALKALI FLUORIDES. S. E. Veazey and Walter Gordy (Duke Univ., Durham, N. C.). Phys. Rev., 138: A1303-11(May 31, 1965).

Rotational transitions of the alkali metal fluorides CsF, ^{87}RbF, ^{85}RbF, ^{39}KF, NaF, and ^7LiF were measured in the millimeter- and submillimeter-wave regions where no previous measurements existed. The work was accomplished with a high-resolution molecular-beam absorption spectrometer, previously utilized for study of the other alkali halides. A more reliable oven was constructed and used to vaporize the alkali fluorides at temperatures up to 1100°C. Measurements on rotational transitions as high as J = 27 → 28 in the first three vibrational states gave Y_{01}, Y_{11}, and Y_{21} more accurately, for the most part, than they were previously known, and gave YO_2 and Y_{12} for the first time. From these Dunham rotational constants were derived potential coefficients, moments of inertia, internuclear distances, and vibrational constants. (auth)

27090 LYMAN-ALPHA PRODUCTION IN H^+-H(1s) COLLISIONS. R. F. Stebbings, R. A. Young, C. L. Oxley, and H. Ehrhardt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Rev., 138: A1312-16 (May 31, 1965).

Lyman-alpha production in collisions between protons and hydrogen atoms was measured in a crossed beam experiment, within the energy range 600 to 30 kev. The Lyman-alpha photons result both from excitation of thermal target atoms — $H^+ + H(1s) \rightarrow H^+ + H(2p)$ — and from electron capture into excited states of the projectiles — $H^+ + H(1s) \rightarrow H(2p) + H^+$. These two processes are experimentally distinguishable in terms of the Doppler shift in the capture radiation. Measurements of the angular distribution of the Lyman-alpha photons, made with an oxygen-filtered iodine-filled counter, enable the signals from the two processes to be separately determined. Relative cross sections so obtained are normalized with the aid of earlier measurements of Lyman-alpha production in e^--H(1s) collisions. The results are discussed in the light of recent theoretical developments. (auth)

27091 COLLISIONAL EXCITATION TRANSFER OF S-P TYPE BETWEEN IDENTICAL ATOMS. Tsutomu Watanabe (Tokyo Univ.). Phys. Rev., 138: A1573-81 (June 14, 1965).

The electronic excitation transfer cross section between identical atoms in S and P states in the gas phase was investigated theoretically in the low-incident-energy range by means of the impact-parameter method. With respect to the P states of an atom, all three degenerate P states of mutually orthogonal polarizations were taken into account. The direction of P polarization was taken into account using two different methods. These methods were the fixed-atom approximation and the rotating-atom approximation, respectively. The difference between the solution from coupled equations with respect to the direction of P-state polarization and those from the respective approximations mentioned above was studied. The fixed-atom approximation was found to be better than the rotating-atom approximation for the computation of the over-all cross section of S–P–type excitation transfer. The cross section obtained from the coupled equations was nearly one-half of that from the rotating-atom approximation and nearly 1.5 times as much as that from the fixed-atom approximation. It is shown that the total cross section can be written as $\sigma = 3.36\pi e^2\mu^2/\hbar v$, where v represents the relative velocity of an incident atom, e the electronic charge, and μ the transition dipole matrix element between the S and P states under consideration. (auth)

27092 TRANSITIONS INDUCED IN HIGHLY EXCITED H ATOMS BY PROTON IMPACT. R. M. May and S. T. Butler (Univ. of Sydney). Phys. Rev., 138: A1586-91 (June 14, 1965).

Transitions induced in highly excited hydrogen atoms (principal quantum number $n \gg 1$) by fast-proton impact are examined. Using Born approximation, the cross section for ionization of the H atom in the limit $n \gg 1$ is derived, and it is shown to be proportional to n^2. Transitions to other highly excited bound states are considered: for cascade transitions $(n, l \rightarrow n + 1, l + 1)$ the cross section is proportional to n^4 lnn; for transitions of the kind $(n, l \rightarrow n, l + 1)$ and $(n, l \rightarrow n + 2, l + 1)$ the cross section goes as

n^3 lnn; other transitions have cross sections proportional to at most n^2 lnn. (auth)

27093 EFFECT OF NUCLEAR SYMMETRY IN ION-ATOM SCATTERING. W. Aberth, D. C. Lorents, R. P. Marchi, and F. T. Smith (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev. Letters, 14: 776-8(May 10, 1965).

The observation of a secondary oscillation appearing only in collisions involving identical nuclei is reported. The suggestion that the secondary peaks appearing in the elastic scattering of $^4He^+$ ions on ^4He at 300 ev center-of-mass energy is due to nuclear symmetry is confirmed by repeating the experiment using ^3He as a target. The ^3He data were normalized by comparison with the ^4He data, and experimental and theoretical differential cross sections are presented. No secondary interference was observed for ^3He-$^4He^+$ scattering, which indicates the absence of nuclear symmetry. (L.B.S.)

27094 COULOMB HOLE IN THE GROUND STATE OF TWO-ELECTRON ATOMS. R. F. Curl, Jr. (Oxford Univ.), and C. A. Coulson. Proc. Phys. Soc. (London), 85: 647-52 (Apr. 1965).

The Coulomb hole $\Delta(r_{12})$ in the ground state of two-electron atoms was calculated. Except for H^-, the function $\Delta(r_{12})$ can be represented by a single curve F(p), where $p = (Z - 0.38)r_{12}$. (auth)

27095 CALCULATIONS OF ATOMIC ASYMMETRIC CHARGE TRANSFER. A. R. Lee and J. B. Hasted (London Univ.). Proc. Phys. Soc. (London), 85: 673-7(Apr. 1965).

Tables are presented from which the cross sections for asymmetric atomic charge transfer may be calculated, using a two-state approximation after the method of Rapp and Francis. A relation similar to the adiabatic maximum rule is derived with the elimination of the empirical 'adiabatic parameter'. (auth)

27096 DISSOCIATION OF HYDROGEN MOLECULAR IONS BY FAST PROTONS. D. R. Bates and A. R. Holt (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 85: 691-702(Apr. 1965).

Inelastic collisions between H_2^+ ions and fast protons are investigated. Using the Cohen–Coulson expansions for the electronic wave functions, calculations are carried out on the first Born approximation to the cross sections associated with transitions from the $1s\sigma$ state to the $2p\sigma$, $2p\pi$, $2s\sigma$ and $3d\pi$ states with the internuclear distance held at its equilibrium value. Dissociation due to the interaction between the projectile and the nuclei of the target is treated classically. With the aid of results due to Peek, cross sections are obtained for $H^+ + H_2^+(1s\sigma,v,J) \rightarrow H^+ + H(1s)$ and for $H^+ + H_2^+(1s\sigma,v,J) \rightarrow H^+ + H^+ + H(\Sigma')$, where Σ' indicates any excited state (including the continuum). (auth)

27097 IONIZATION OF HYDROGEN, HELIUM, LITHIUM AND BERYLLIUM BY ELECTRON AND PROTON IMPACT. G. Peach (London Univ.). Proc. Phys. Soc. (London), 85: 709-18(Apr. 1965).

Cross sections for the ionization of H, He, Li and Be in their ground states by electron and proton impact are calculated, using Born's approximation. In each case, partial-wave cross sections are calculated by expanding in terms of the angular momenta of the ejected electron. Hartree–Fock wave functions are used for all the initial and final bound states of the non-hydrogenic atoms, together with an undistorted Coulomb function for the ejected electron. The relative contributions to the total cross sections from each partial wave are studied in detail, and for hydrogen and helium about two-thirds of the total arises from the partial-wave cross section for $l = 1$. In the cases in which a transition from a 2s state is involved, the allowed part is less important; and it is necessary to consider separately contributions to the total from all partial waves up to $l = 5$. In the cases in which there are other theoretical calculations or experimental measurements available, agreement is good in the regions of validity of the first Born approximation. (auth)

27098 ELASTIC SCATTERING OF SLOW ELECTRONS BY HELIUM. J. H. Williamson and M. R. C. McDowell (Univ. of Durham, Eng.). Proc. Phys. Soc. (London), 85: 719-22(Apr. 1965).

Phase shifts for elastic collisions between electrons and helium atoms are calculated for $l = 0$, 1, and 2 by numerical integration of the scattering equation in a one-channel approximation. When a polarization potential is included, the zero energy cross section is found to be 16.50 a_0^2. (auth)

27099 THE DISTRIBUTION OF ROTATIONAL ENERGY IN N_2^+ EXCITED BY 3 kev Li^+ IONS. R. P. Lowe and H. I. S. Ferguson (Univ. of Western Ontario, London, Can.). Proc. Phys. Soc. (London), 85: 813-15(Apr. 1965).

The results obtained by Reeves and Nicholls in 1961 on the distribution of rotational energy in N_2^+, formed by 2.0- and 3.2-kev Li^+ ion excitation of N_2, were interpreted as indicating a rotational disequilibrium in the target molecule. This work was extended to much higher rotational quantum numbers, and it was shown that the rotational levels are in fact populated according to a Boltzmann distribution at a greatly elevated rotational temperature of approximately 3500°K. (auth)

27100 NUMBER OF ELASTIC ELECTRON-ATOM COLLISIONS WITHIN PLANAR BOUNDARIES. R. J. Fleming (Royal Military Coll. of Science, Swindon, Eng.). Proc. Phys. Soc. (London), 85: 817-19(Apr. 1965).

A recently introduced method of calculating the mean number of elastic electron-atom collisions was applied to the case of diffusion between planar boundaries. The results obtained for scattering of electrons at 20 ev on helium atoms are some 9% higher than the corresponding values from the standard Harries–Hertz formula. (auth)

27101 SECONDARY ELECTRON EMISSIONS OF CERTAIN OXIDES AND CHALCOGENIDES OF THE III, IV, AND V GROUPS. V. L. Makedonskii. Radiotekhn. i Elektron., 10: 518-21(Mar. 1965). (In Russian)

With the help of the pulse method, the dependence of the coefficients of secondary electron emission on the energy of the primary electrons U_p was investigated for volatilized films of Sb_2S_3, Sb_2Se_3, Sb_2Te_3, Sb_2O_3, As_2S_3, As_2Se_3, As_2Te_3, Bi_2S_3, Se, Ga_2Se_3, In_2Se_3, GeS, PbO, La_2O_3, CeO_2, TeO_2, B_2O_3, and monocrystalline PbS in the U_p interval from 1.5 to 1500 to 2000 ev. The characteristic $\sigma(U_p)$ was determined for part of the compounds studied. For all groups of compounds the connection between the value σ_{max} and the size of the coefficients of secondary electron emission was followed for small energies of the primary electrons (3 ev), which were examined as the manifestation of the volumetric character of the elastic scattering process of primary electrons for low U_p in determination of part of the compounds studied. (tr-auth)

27102 CATHODIC SPUTTERING OF TANTALUM AND TUNGSTEN AT VARIOUS TEMPERATURES. V. A. Shustrov, R. M. Khasanov, and A. Kh. Ayukhanov. Radiotekhn. i Elektron., 10: 541-7(Mar. 1965). (In Russian)

The sputtering of W and Ta by K^+, Na^+, and Li^+ at various temperatures was investigated using isotope tracer techniques. The experimental apparatus made it possible to investigate sputtering at temperatures when the thermal evaporation of the materials investigated became first order with sputtering. It is shown that the curve of the dependence of the sputtering coefficients on temperature passes through a minimum, the existence of which is connected with the sputtering of chemical compounds of the metals with gases, adsorbed from the apparatus volume. It was established that the sputtering of clean surfaces of W or Ta was possible even at temperatures greater than T_K, characteristic for these metals. (tr-auth)

27103 ANOMALIES OF THE EMISSION AT HIGH ATOMIC LEVELS OF Zn AND Pb IN COOLING SPARKS. J. Hingsammer, L. Krauss, and H. Krempl (Technische Hochschule, Munich). Z. Naturforsch., 20b: 189-92 (Mar. 1965). (In German)

The higher atomic levels of Zn and Pb were investigated; these show an anomalous effect in the intensity-time function of the spark discharge. The intensity maxima appear at lower temperatures as was expected. The anomalous effect can be explained by the action of the electric field of the plasma. (auth)

27104 DETECTION OF THE MULTIFOLD EMISSION OF SECONDARY ELECTRONS BY MEANS OF A PROPORTIONAL COUNTER. K. H. Simon, M. Herrmann, and P. Schackert (Universitat, Mainz). Z. Physik, 184: 347-51(Apr. 15, 1965). (In German)

A proportional counter is used as analyzer for electron energies (in the range 10 to 20 kev). The resolving power for 20 kev is 21%. The multiple emission of secondary electrons is investigated with this counter. (auth)

27105 THEORY OF STIMULATED RAMAN EFFECTS. K. Grob (Technische Hochschule, Stuttgart). Z. Physik, 184: 395-432(Apr. 15, 1965). (In German)

Stimulated Raman emission in solids, placed in a plane laser beam external to the cavity is considered. The hamiltonian of the system of phonons, electrons, and electromagnetic fields is derived within the framework of a generalized adiabatic approximation for electrons and nuclei. It contains terms due to nonlinear interactions between electrons and phonons. Because the usual time-dependent perturbation theory cannot describe coherence effects properly, Heisenberg's equations of motion for the operators of photons, phonons and electron excitations are used. In order to solve these equations in the steady state an iteration procedure is applied. The light waves give rise to electron transitions. The electrons such excited create phonons which then react on the electrons. Finally the electrons are coupled again to the lightfield. This procedure yields besides the usual well-known Raman process two main processes occurring in stimulated Raman emission: a coupled two step Raman process and a parametric process. In the first one two phonons are involved. If the linewidth of phonons is comparable to the phonon frequencies the non-resonant parts of the above processes also become important. In solving the set of coupled equations for the light amplitudes, obtained from the iteration procedure, only terms due to the first Stokes, the first anti-Stokes, and the laser line are considered. Frequency shifts of these lines due to the stimulated emission, which are of the order of the linewidth of photons if this linewidth is very much smaller than that of phonons as it is the case in solids, are found. This means that the coupled two step Raman process is dominant, in good agreement with measurements of Chiao and Stoicheff in calcite. (auth)

27106 EXPERIMENTS ON THE PRODUCTION OF POLARIZED ELECTRONS FROM ATOMIC BEAMS. F. Bopp, D. Maison, G. Regenfus, and H. Chr. Siegmann (Universitat, Munich). Z. Physik, 185: 48-53(1965). (In German)

The maximal intensity of a polarized electron beam one can extract from an atomic beam with available light sources is determined. The real electron intensity is much smaller and depends on the technical effort. Measurements are in contradiction to the statements of H. Friedmann. Several experimental set-ups are investigated. (auth)

27107 MEASUREMENT OF THE VAN DER WAALS POTENTIALS BETWEEN ALKALI ATOMS. U. Buck and H. Pauly (Universitat, Bonn). Z. Physik, 185: 155-68 (1965). (In German)

Total collision cross sections for the interaction between alkali atoms were measured using a modulated atomic beam technique. Since the determination of the density in the scattering chamber is the main source of error in absolute scattering measurements, particular attention is given to this problem: The cross section for partners A and B is measured first with A as beam particles and B as target particles, and then with B as beam particles and A as target particles. The data are used to deduce the long range van der Waals (inverse sixth power) potential constants, which can be compared with theoretically calculated values of different authors. The interaction constants resulting from the present measurements are in good agreement with those calculated by Fontana, while other calculations give much larger values. (auth)

27108 ON THE DEPENDENCE OF THE DEGREE OF POLARIZATION ON SCATTERING ANGLE IN MOTT SCATTERING OF SLOW ELECTRONS. H. Deichsel and E. Reichert (Universitat, Mainz). Z. Physik, 185: 169-77 (1965). (In German)

The angular dependence of polarization $P(\Theta)$ of electrons elastically scattered by a beam of mercury atoms is measured in a double scattering experiment for electron energies of 0.9, 1.2, and 1.5 kev. The results are compared with theory and found to be in good agreement. Maximum degree of polarization measured is $P = 0.53 \pm 0.10$ (electron current 10^{-12} amp). (auth)

27109 INFLUENCE ON SURFACE IONIZATION OF ADATOM MIGRATION ALONG A NONUNIFORM SURFACE. N. D. Potekhina (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 35: 317-24(Feb. 1964). (In Russian)

The effect of adatom (adsorbed atom) migration on surface ionization is discussed. The ionizing surface is assumed to consist of alternating regions of two kinds which differ in work function and heat of desorption, the regions with the greater work function having also the larger heat of desorption. The equations for a stationary state are written, the influence of the contact potential field above the metal surface on the motion of the ions is taken into account, and the solution is discussed for the cases of weak, moderate, and strong migration. A strong external electric field is found to reduce the influence of migration. The time dependent equations for nonstationary conditions are written, and their solution is discussed, for cases of weak, moderate and strong migration. It is found that the influence of adatom migration on surface ionization is important only under conditions deviating widely from equilibrium. (ATD)

27110 SURFACE TENSION OF H_2-HD AND $HD-D_2$ SOLUTIONS. V. N. Grigor'ev. Zh. Tekhn. Fiz., 35: 332-8 (Feb. 1965). (In Russian)

The surface tension of H_2–HD and $HD-D_2$ solutions was measured by a capillary rise method at temperatures from 20.5°K to the crystallization temperature. The measurements were undertaken to test the suggestion that the lack of spherical symmetry of the H_2 molecule may play an important role in the behavior of H_2-D_2 solutions, since HD molecules may be expected to deviate even more from spherical symmetry than H_2 molecules. The solutions were prepared by mixing in the gaseous phase and repeated condensation and vaporization. The densities of the solutions were computed from those of the pure components on the assumption of additivity of molecular volumes. The measured surface tensions all exhibited the same linear dependence on temperature over the range investigated. The concentration dependence of the surface tension of the solutions deviated from additivity in the negative direction by a maximum of about 2.5%. The experimental curves are compared with theoretical calculations based on the quantum principle of corresponding states with surface absorption corrected by the formula of Englert-Chwoles and Prigogine. The theory represented the general course of the H_2-HD curve and was in quantitative agreement with the $HD-D_2$ curve. It is concluded that the lack of spherical symmetry of the HD molecule does not exert any significant influence on the surface tension of its solutions. (ATD)

Cosmic Radiation

See also Elementary Particles and Radiations. Nuclear Properties and Reactions.

Refer also to abstract 27462.

27111 (INSJ-82) ANALYSIS OF THE HIGH-ENERGY JET SHOWERS. I. MONTE CARLO TEST OF THE NEW FORMULAE. Shun-ichi Hasegawa, Akizi Outi, and Nobuo Yajima (Institute for Nuclear Study, Univ. of Tokyo (Japan)). Dec. 21, 1964. 42p. Dep.(mn).

The method introduced for the kinematical analysis of high-energy nuclear jet showers is examined using the Monte Carlo method. The angular distribution and the dis-

tribution of the transverse momenta of emitted pions are assumed to be of the type of $\cos^m \theta$ and $P_T \exp |-P_T^2/P_0^2|$, respectively. Furthermore, the number of emitted charged pions is assumed to be two thirds of the total number of emitted pions. For each artificial jet thus obtained, the reliability of formulas proposed previously is examined. These numerical experiments show that the formulas are a good approximation for practical use. (auth)

27112 (P-2496(RAND)) SOME THEOREMS CONCERNING THE MOTION OF AN ELECTRICALLY CHARGED PARTICLE IN A DIPOLE MAGNETIC FIELD. Ernest C. Ray (RAND Corp., Santa Monica, Calif.) and Joseph E. Kasper (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). Dec. 1961. 30p. (AD-606760)

Various theorems related to the application to cosmic rays of the theory of the motion of a charged particle in a dipole magnetic field are proved. The theorems are essentially those conjectured by Schremp. In making the proofs, it is assumed that the so called trajectories of the first and second kinds have certain properties in the large. These properties can be verified numerically and by series expansions in any particular case. (auth)

27113 DIRECTIONAL STUDIES OF ENERGETIC COSMIC-RAY MUONS: ANISOTROPY OF GALACTIC COSMIC RADIATION. R. P. Bukata and S. Standil (Univ. of Manitoba, Winnipeg). Can. J. Phys., 43: 883-97(May 1965).

The use of a pair of equatorially mounted, narrow-angle, high-energy particle telescopes to effect an experimental study of energetic, directionally selected muons at the University of Manitoba in Winnipeg, Manitoba, is described. Experimental results are presented which indicate anisotropies up to ~15% in the primary radiation above about 40 Bev arriving at the earth in or near the equatorial plane. Preferred arrival directions were found, the most prominent being given by a RA of 20.5 ± 1 hour. Evidence is also presented for the existence of a solar modulation of the primary radiation. (auth)

27114 CHARACTER OF THE SPATIAL-TEMPORAL DISTRIBUTION OF SOLAR COSMIC RAYS IN INTERPLANETARY SPACE. L. I. Dorman and L. I. Miroshnichenko (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 730-4(1964).

The space-time distribution of solar cosmic radiation in interplanetary space was investigated on the basis of the diffusion model of the propagation of solar particles. (D.C.W.)

27115 STUDY OF THE VARIABILITY OF THE GENERAL IONIZING COMPONENT OF COSMIC RAYS. Yu. Dubinski and L. Khaloupka (Shafarik Univ. and Inst. of Physics, Czechoslovak Academy of Sciences, Kosice). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 734-5(1964).

The preliminary results of an analysis of measurements made at Novolazarevskaya during the period June–Dec. 1962, on the ionizing component of cosmic radiation are presented. The variation of the cosmic-ray intensity was studied in relation to certain variations of the magnetic field recorded at this station. (D.C.W.)

27116 THE TEMPERATURE EFFECT OF THE COSMIC-RAY NEUTRON COMPONENT DURING A PERIOD OF HIGH SOLAR ACTIVITY. N. S. Kaminer, S. F. Ilgach, and T. S. Khadakhanova (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences USSR and Zhdanov State Univ., Irkutsk, USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 736-7 (1964).

The intensity variations of the neutron component of cosmic radiation during the period 1957-1959 were studied, excluding variations of the primary component. It was concluded that in years of both high and moderate solar activity, there is a stable seasonal wave in the neutron component, probably due to seasonal temperature changes in the atmosphere. (D.C.W.)

27117 THE MEAN FREE PATH OF NUCLEAR-ACTIVE PARTICLE INTERACTIONS AT ENERGIES OF $>10^{11}$ ev. N. L. Grigorov, I. N. Erofeeva, L. G. Mishchenko, V. S. Murzin, I. D. Rapoport, L. I. Sarycheva, and V. A. Sobinyakov (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1798-1800(Nov. 1964). (In Russian)

An ionization calorimeter was used to determine the mean free path of nuclear-active particle interactions in iron, carbon, and lead at incident energies greater than 10^{11} ev. The results for iron, carbon, and lead are 140, 90, and 172 g/cm^2, respectively. (C.E.S.)

27118 ABSOLUTE INTENSITY AND ENERGY SPECTRUM OF NUCLEAR-ACTIVE PARTICLES AT 3260 m ELEVATION. N. L. Grigorov, I. N. Erofeeva, L. G. Mishchenko, V. S. Murzin, I. D. Rapoport, L. I. Sarycheva, and V. A. Sobinyakov (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1801-2(Nov. 1964). (In Russian)

An ionization calorimeter was used for investigating the form of the energy spectra and determining the absolute intensity of cosmic radiation. The calorimeter operates efficiently for particles in the energy range 2×10^{11} to 2×10^{12} ev. The absolute intensity of nuclear-active particles at mountain heights (3260 m above sea level) was found to be $(5.9 \pm 0.8) \times 10^{-6}$ cm^{-2} sec^{-1} ster^{-1}. (C.E.S.)

27119 LARGE ATMOSPHERIC SHOWERS OF COSMIC RADIATION. G. T. Zatsepin, S. I. Nikol'skii, and G. B. Khristiansen. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1876-85(Nov. 1964). (In Russian)

Electrons constitute the most numerous part of charged particles in the atmospheric showers, and the loss of electrons in the ionization process causes the expenditure of much energy by absorption of shower particles during passage through the atmosphere. The results of measurements prove that Coulomb electron dispersion in atmospheric showers is the fundamental process which determines the spatial distribution of electrons and photons with energies near the critical energy in the radiation flux. The total energy ϵ of electrons and photons at the mean density of showers is $\epsilon = 1.9 \times 10^8$ Mev at sea level and $\epsilon = 2.1 \times 10^8$ Mev on mountains. The spectra of high-energy primary radiation were investigated by means of a special installation. Changes in the energy spectrum and the composition of primary cosmic rays occur simultaneously in the magnetic field, the strength of which determines the value of the diffusion coefficient. The energy spectrum and the composition of metagalactic rays differ from those of galactic origin. Metagalactic rays are rich in protons and light nuclei of the same energy as those of the galactic origin. The density of the meson (μ) flux in usual showers is found to be tens and hundreds of times greater than that obtained from theoretical computations. (ATD)

27120 NEW DATA ON THE STUDY OF BROAD ATMOSPHERIC SHOWERS USING A COMPLEX APPARATUS. S. N. Vernov, G. B. Khristiansen, A. T. Abrosimov, I. F. Belyaeva, V. A. Dmitriev, G. V. Kulikov, Yu. A. Nechin, V. I. Soloveva, and B. A. Khrenov (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1886-93(Nov. 1964). (In Russian)

Experiments are described that were conducted at Moscow State University on a complex apparatus for the study of broad atmospheric showers and the meson (μ) component of cosmic rays. The apparatus gave simultaneous information on the electron-photon, meson (μ), and nuclear-active components of broad atmospheric showers in each individually recorded shower. (ATD)

27121 RESULTS FROM THE IMP 1 GM COUNTER TELESCOPE EXPERIMENT. V. K. Balasubrahmanyan, G. H. Ludwig, F. B. McDonald, and R. A. R. Palmeira (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 70: 2005-19(May 1, 1965).

The results from the Geiger-Mueller (GM) counter telescope on board the Imp 1 satellite are presented. The detector system consisted of four pancake-type GM counters forming two mutually perpendicular telescopes and an omnidirectional detector. Comparison of the intensity measured by the two perpendicular telescopes revealed

an anisotropy in the recovery phase of the 11-year variation. Time variations of the omnidirectional intensity were correlated with the planetary index K_p, and inferences about interplanetary field irregularities and solar wind cavity structures are presented. These results are shown to be in general agreement with Parker's description of the cosmic-ray modulation by the solar wind. (auth)

27122 SOLAR COSMIC RAYS ASSOCIATED WITH METER TYPE IV RADIO BURSTS. Sekiko Yoshida (Univ. of Alaska, College). J. Geophys., Res., 70: 2065-75 (May 1, 1965).

The reality of a "statistical" solar cosmic-ray increase has been claimed by some workers and questioned by others. In the present study, a definite statistical increase is found to be associated with solar events producing meter type-IV bursts. On the other hand, decimeter and microwave type IV's, unaccompanied by meter IV's, are not associated with any increase. Cosmic-ray data from 21 stations distributed over the world and covering the period July 1957 through December 1960 are used. The statistical increase, in contrast to the large, unusual increase, is too small to show up definitely in the data for a single event from a single station; superposition of observations is required to bring out any effect. The magnetic cutoff rigidity dependence is similar for the statistical increase and the large, unusual increase, if the latter is measured several hours after the flare. The statistical increase has an isotropic particle flux distribution, and the time delay from the flare to the intensity maximum of the statistical increase is about 8 to 18 hours. (auth)

27123 POSSIBLE DETERMINATION OF THE SOLAR WIND COMPOSITION. Peter Signer (Univ. of Minnesota, Minneapolis), Peter Eberhardt, and Johannes Geiss. J. Geophys. Res.,'70: 2243-4(May 1, 1965).

A method for accumulating solar-wind particles over an extended period of time and over a large area is proposed, in which an electrostatic potential is applied to a foil that is exposed to the solar wind. (D.C.W.)

27124 DETECTING COSMIC RAYS BY RADIO. J. V. Jelley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). New Scientist, 26: 168-71(Apr. 15, 1965).

The experimental detection of giant cosmic showers by the radio emission from the showers is reviewed, with consideration of the development and properties of extensive air showers and the mechanism of radio emission. (D.C.W.)

27125 BALLOON MEASUREMENTS OF COSMIC RAYS AND RADIOACTIVE DEBRIS NEAR ROME IN 1962. S. Cantarano, A. M. Conforto, A. Egidi, F. Mariani, and M. Terenzi (Universita, Rome and CNR, Rome). Nuovo Cimento (10), 37: 793-817(June 1, 1965).

A series of cosmic-ray balloon flights was carried out in 1962 near Rome. The instrumentation used is described, and the results are reported. It is shown that all the intensity versus height profiles obtained correspond to quiet solar and geomagnetic conditions, so that some reference height profiles of the normal cosmic-ray intensity at this latitudes are now available. Exceptional intensity increases observed in three occasions (Oct. 25, 26, and Nov. 17) at altitudes above 16 km are connected with the radioactive debris produced by some of the intensive nuclear tests carried out in that period both by the Soviet Union and the United States. The dimensions and the specific activity of the radioactive layers traversed by our instruments are estimated. A comparison with figures reported by others underlines the remarkable size of the Nov. 17 event, when the observed activity was not less than 50 $\mu C/m^3$. Some slight indications of a correlation with an increase of ground β activity are also suggested. (auth)

27126 LATITUDE EFFECT ON NEUTRON ALBEDO FLUX. G. Boella (Universita, Milan and Istituto Nazionale di Fisica Nucleare, Milan), G. Degli Antoni, C. Dilworth, L. Scarsi, G. Pizzi, and M. Tagliabue. Nuovo Cimento (10), 37: 1232-5(June 1, 1965).

A slow neutron counter with 2-in. hemispherical polyethylene moderator was flown at Kiruna (cut-off rigidity ~0.5 Bv) in Oct. 1964 to obtain information on the latitude effect. The variation with atmospheric depth of the latitude effect observed with the detector, whose maximum sensitivity lies in the region of neutron energies between 10 kev and 1 Mev, was explained by assuming that at high altitude the neutron energy spectrum varies with latitude. (C.E.S.)

27127 TECHNIQUES FOR THE MEASUREMENT OF EXTRA-TERRESTRIAL SOFT X-RADIATION. R. L. F. Boyd (London Univ.). Space Sci. Rev., 4: 35-90(Feb. 1965).

A review of techniques and instrumentation for the measurement of extra-terrestrial x radiation in the wavelength range of 1 to 100 Å is presented. 90 references. (D.C.W.)

27128 HIGH ENERGY COSMIC GAMMA RAYS. G. Garmire and W. L. Kraushaar (Massachusetts Inst. of Tech., Cambridge). Space Sci. Rev., 4: 123-46(Feb. 1965). (MIT-2098-88)

Possible mechanisms for the absorption and emission of cosmic gamma radiation are briefly discussed, together with the fluxes and intensities to be expected from a number of astronomical objects and regions. The available experimental information is summarized. 50 references. (D.C.W.)

27129 LES RAYONS COSMIQUES. (Cosmic Rays). Max Morand. Collection Armand Colin. No. 360. Section de Physique. Paris, Librairie Armand Colin, 1963. 211p.

A review on cosmic radiation is presented, covering the discovery and investigation of cosmic showers, the various components of cosmic radiation, and isotropy and time effects in cosmic radiation, as well as data from satellites and the principal theories. (D.C.W.)

27130 VARIATSII KOSMICHESKIKH LUCHEI VYSOKIKH ENERGII. (The Variations of High-Energy Cosmic Rays). A. I. Kuz'min. Moscow, Izdatel'stvo "Nauka," 1964. 127p.

A review is given of the data on cosmic rays at various depths underground. The instruments used are described. Various types cosmic rays are discussed. General concepts of the nature of cosmic variations, dynamics of the upper atmosphere, and structure of cosmic space are evaluated on the basis of the collected data. Data on the intensity of cosmic muons at 7, 20, and 60 m underground measured during 1958–59 are tabulated. (R.V.J.)

Direct Energy Conversion

27131 (IRD-64-36(Pt. 3)) RESEARCH PROGRAMME ON MAGNETOPLASMADYNAMIC POWER GENERATION. PART 3. THEORETICAL. Technical Summary Report, December 1, 1962–March 31, 1964. B. C. Lindley (International Research & Development Co. Ltd., Newcastle-upon-Tyne (England)). Contract N62558-3127. 250p. $6.00(CFSTI).

The viscosity of gaseous Cs was calculated and the part played by ionization assessed. The viscosity of Cs–He mixtures was next investigated, and the general behavior of the viscosity of binary gas mixtures is then examined. The experimental measurements of collision cross sections for cesium are compared; the value of 300×10^{-16} cm^2 is a good approximation. The electric conductivity of helium-cesium mixtures is calculated as a function of seeding fraction and electron temperature, and the power of magnetoplasmadynamic (MPD) generators is calculated therefrom. A study was made of nonequilibrium nozzle flow in MPD generators; calculations were made of the electric conductivity through a nozzle for He seeded with 1 at.% Cs. Flow equations were solved for MPD generators for both the cases of ionization equilibrium and nonequilibrium. The theory of constant Mach number flow in a closed-cycle generator is considered, and the inefficiency of the Hall generator is pointed out. The problem of optimization of nuclear-cycle MPD generators is considered. A brief review is presented of some of the advanced power conversion systems for space missions, particularly high-power systems. Methods for extra-thermal ionization in MPD generators are considered; nonequilibrium flow of a plasma

through a nozzle was examined using a theoretical model. A three-level model is used to study ionization and recombination in a nonequilibrium Cs plasma. (D.L.C.)

27132 (NP-14819) RESEARCH ON NEW CONCEPTS IN ENERGY CONVERSION. Quarterly Technical Progress Report No. 5, September 1, 1964–November 30, 1964. W. D. Jackson, G. A. Brown, J. L. Kerrebrock, and R. E. Stickney (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Dec. 15, 1964. Contract AF33(615)-1083. 23p.

Research and development are reported on magnetohydrodynamic power generation using liquid metals. Magnetohydrodynamic induction generators, alkali-metal generators, and thermionic energy conversion. (J.R.D.)

27133 THERMIONIC ANALYSIS BY USE OF A DIGITAL COMPUTER. Vincent C. Truscello, Albert R. Leiberman, and Thomas S. Bustard (Martin Co., Baltimore). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 2, 46-52(Apr. 1965).

An IBM digital computer program was developed to semi-empirically predict diode performance. Experimental curves of voltage versus current are presented for tantalum, molybdenum, and rhenium for a wide range of emitter and cesium temperatures. These are processed by the program to determine the optimum efficiency characteristics for various emitter temperatures. Graphical presentations of the processed data indicate the maximum obtainable efficiencies using any of the three emitter materials. The corresponding values of cesium temperature and diode voltage necessary to obtain this efficiency and the corresponding power densities are also presented. (auth)

27134 THEORY OF LARGE-AMPLITUDE OSCILLATIONS IN THE ONE-DIMENSIONAL LOW-PRESSURE CESIUM THERMIONIC CONVERTER. Peter Burger (Stanford Univ., Calif.). J. Appl. Phys., 36: 1938-43(June 1965).

The large-amplitude oscillations in a one-dimensional, low-pressure cesium thermionic converter are analyzed. With the help of results obtained from computer calculations designed to simulate the operation of the converter, the current oscillations are explained in terms of the changing forms of the potential distribution in the system. The variations in the form of the potential function are explained by means of the concept of a temporary d-c state. Such a state differs from the ideal self-consistent state in that the electrons and the potential adopt new distributions while the ion distribution stays the same as in the self-consistent state. In fact, the ions are treated as too heavy to respond to the new potentials while the electrons adjust themselves rapidly to them. The existence of a temporary d-c state is decided by solving a static problem only; but if such a state exists, then there is a possibility for relaxation-type oscillations in the system with frequencies characteristic of the ions. (auth)

27135 DIRECT ENERGY CONVERSION. Eleven Technical Papers by RCA Scientists and Engineers. Camden, N. J., Radio Corp. of America, 1963. 44p.

A survey of research at RCA on direct energy conversion is presented. Eleven papers are included, dealing with thermionic cells, thermoelectric cooling, solar cells, MHD cells, batteries, thermoelectric cells, and superconducting magnets. (D.C.W.)

Elementary Particles and Radiations

Refer also to abstract 27306.

27136 (CALT-68-25) REGGE TRAJECTORIES VS. VANISHING RENORMALIZATION CONSTANTS AS DYNAMICAL CRITERIA. P. E. Kaus (California Univ., Riverside) and F. Zachariasen (California Inst. of Tech., Pasadena). Jan. 1965. Contracts AT(11-1)-68 and AT(11-1)-34. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The connection between Reggeness and the vanishing of renormalization constants is explored. It is found that if in a field theory, $Z_1 \to 0$, and $Z_3 \to 0$, such that $Z_1/Z_3 \to 0$, then a Regge trajectory moves smoothly under an elementary particle pole so that the particle becomes dynamical in the Regge sense. Thus a bootstrapped world may perhaps equally well be defined as being a field theory with all renormalization constants set equal to zero, as by saying all particles lie on Regge trajectories. (auth)

27137 (CEAL-1014) HIGH-ENERGY PHOTONS FROM COMPTON SCATTERING OF LIGHT ON 6.0-GEV ELECTRONS. C. Bemporad, R. H. Milburn, N. Tanaka, and M. Fotino (Cambridge Electron Accelerator, Mass.). Jan. 30, 1965. Contracts AT(30-1)-2076 and AT(30-1)-1984. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The 6943-Å emission line of a ruby laser is caused to interact head-on with the 6-Bev internal electron beam of the Cambridge Electron Accelerator. The results indicate that Compton scattering of the photons by the electrons produces 0.85-Bev photons with 99% plane polarization. (T.F.H.)

27138 (IC/65/36) MASS FORMULAE FOR BARYONS IN $\widetilde{SU}_3$. G. Bisiacchi and C. Fronsdal (International Centre for Theoretical Physics, Trieste (Italy)). Apr. 1965. 12p. Dep.(mn).

The mass formulas of baryons are studied for the noncompact $\widetilde{SU}_3$ symmetry group. It was found that the U-space equal spacing hypothesis leads to the Okubo formula, and hence the $\widetilde{SU}_3$ predictions agree with SU_3 predictions. The $\Xi^*_{\frac{1}{2}}$ and masses are predicted to be ~1440 and 1455 Mev, while the $\Xi^0_{\frac{1}{2}}$ and $\Xi^-_{\frac{1}{2}}$ would decay electromagnetically into Ξ^0 and Ξ^-. (D.L.C.)

27139 (INSJ-81) PROTON COMPTON EFFECT (thesis). Yorikiyo Nagashima (Institute for Nuclear Study, Univ. of Tokyo (Japan)). Dec. 25, 1964. 66p. (TH-47). Dep.(mn).

The cross section of the elastic scattering of photons by protons and the cross section of π^0 photoproduction have been measured for photons with energies from 300 to 700 Mev at 90° cms angle, using a spark chamber technique. Our Compton data smoothly connect the data below the 3-3 resonance and those around the second resonance energy region. The π^0 production cross sections agree with previous works. A theoretical interpretation of the experimental data of Compton scattering for photon energies up to ~1 Bev is presented. The discussions are based on the isobar model. The experimental large cross section around 600 Mev and the relative shift of the 2nd resonance peak to lower energy side by 50 Mev is explained by the inclusion of $T = J = \frac{1}{2}$ resonance at 600 Mev. In contrast to the discussions based on the analysis of pion-nucleon scattering, this analysis seems to be more favorable to odd parity for that resonance. Effects of scalar boson exchange term are discussed. (auth)

27140 (IS-1140) A MASS FORMULA FOR THE BARYON MASS SPECTRUM. Charles L. Hammer and Thomas A. Weber (Ames Lab., Iowa State Univ. of Science and Tech.). Apr. 1965. Contract W-7405-eng-82. 20p. Dep.; $1.00(cy), 1(mn) CFSTI.

A mass spectrum of the form $m^2 = M_l(M_l + |\alpha_l|)$ is derived, where α_l is the imaginary part of the lth singularity in the complex energy plane of a T-matrix which describes the interaction of a particle of initial rest mass m with a potential V(x,t), where V(x,t) = 0 in the limit $|t| \to \infty$. This spectrum is found to give, within 1%, the mass of all baryons less than or equal to the mass of the Ω^- if m is taken as 1747 Mev and α_l is a small integral multiple of the K and π meson masses. Comparison to the Gell-Mann, Okubo formula relates these integers to the hypercharge and the isotopic spin. The analysis proposed by R. L. Lander is used to show that the results can have statistical significance. (auth)

27141 (ISS-64/41) MISURE DI FOTOPRODUZIONE DI MESONI π^+ MEDIANTE COINCIDENZE NEUTRONE-PIONE. (π^+ Photoproduction on Proton Through a Pion-

Neutron Coincidence Method). M. Grandolfo (Istituto Superiore di Sanita, Rome (Italy)). Laboratori di Fisica). Nov. 18, 1964. 60p. Dep.(mn).

Results are reported of a study of π^+ photoproduction measured through a pion-neutron coincidence method. Pulse shape discrimination is used for neutron detection. Experimental results are discussed. (auth)

27142 (ISS-64/46) PROGETTO PER UN'ESPERIENZA $\gamma + p \rightarrow p + \pi^+ + \pi^-$ DA EFFETTUARSI IN CAMERA A DIFFUSIONE PRESSO L'ELETTROSINGROTRONE DI FRASCATI. (A Proposal for an Experiment $\gamma + p \rightarrow p + \pi^+ + \pi^-$ to be Carried Out by Means of a Diffusion Chamber at the Frascati Electron Synchrotron). G. Cortellessa and P. Salvadori (Istituto Superiore di Sanita, Rome (Italy)). Laboratori di Fisica). Nov. 25, 1964. 24p. Dep.(mn).

Theoretical reasons are discussed for a differential cross section measurement of the $\gamma + p \rightarrow p + \pi^+ + \pi^-$ reaction in the photon energy region between the threshold and 1 Bev. The proposed experimental technique, i.e., pressurized hydrogen-filled diffusion chamber in magnetic field, is described. The total number of pictures and the analysis and measurement work necessary for increasing the experimental information till now available, is discussed. (auth)

27143 (JINR-E-2085) SELF-CONSISTENT CALCULATION OF THE K* RESONANCE PARAMETERS. P. S. Isaev and G. M. Radutskii (Joint Inst. for Nuclear Research, Dubna (USSR)). Lab. of Theoretical Physics). 1965. 16p. Dep.(mn).

The Balaz's method is used to calculate the position and the width of the K* resonance. The dependence of the solutions on the parameters is studied. (auth)

27144 (JINR-P-1964) OBSHCHII VID RESHENIYA URAVNENII CHU-LOU I ZAVISIMOST S-FAZ π-N RASSEYANIYA OT IZOTOPICHESKOGO SPINA. (A General Solution of Chew-Low Equation and the Dependence of Scattering Phases on the Isotopic Spin). V. A. Meshcheryakov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 15p. Dep.(mn).

General solutions of Chew-Low equations are found for S, P, D.... partial waves. The multiplicity of these solutions is established. It is shown that the strong dependence of S phases of πN scattering on the magnitude of the total isotopic spin of the πN system can be understood in the framework of unitarity and crossing symmetry. (auth)

27145 (JINR-P-1971) OPTIMIZATSIYA IZMERENII ENERGII ELEKTRONOV V PUZYR'KOVYKH KAMERAKH S TYAZHELYMI ZHIDKOSTYAMI. (The Optimal Conditions for Measuring the Electron Energy in Heavy-Liquid Bubble Chambers). Yu. A. Budagov, A. G. Volod'ko, V. B. Flyagin, and P. V. Shlyapnikov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1965. 8p. Dep.(mn).

It is shown that if the measurement error is included in the uncertainty in the electron momentum the optimal length of the track will increase with increasing electron energy. In this connection the cut-off of the spectrum of the radiation losses is extended to a higher energy region. The formulas for the mean value of the electron momentum and its error are obtained. They prove to be valid for the whole spectrum of possible values of the cut-off threshold. (auth)

27146 (JINR-P-1974) ELEKTROMAGNIHIYE RASPADY I RASSHCHELPENIE MASS VEKTORNYKH MEZONOV V UNITARNOI SIMMETRII. (Electromagnetic Decays and Mass Splitting of Vector Mesons in Unitary Symmetry). Dao Wong Duc and Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy and Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 7p. Dep. (mn).

A possibility of determining the renormalization mass constant of the unitary octuplet of vector mesons is treated on the basis of a study of the neutral vector meson decays into the $\mu^+\mu^-$, e^+e^- pairs. (auth)

27147 (JINR-P-1979) O VOZMOZHNOSTI IZUCHENIYA SLABYKH VZAIMODEISTVII PRI VYSOKIKH ENERGIYAKH S POMOSHCH'YU NEUPRUGIKH π-N STOLKNOVENII. (On a Possibility of Studying High-Energy Weak Interactions by Means of Inelastic πN Collisions). N. F. Truskova (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 5p. Dep.(mn)

A choice of the most interesting cases of $\pi + N \rightarrow e + \nu + N + n\pi$ interactions is suggested, using the Treiman-Yang criterion. The corresponding one-pole diagrams are estimated at different collision energies. (auth)

27148 (JINR-P-1998) MYUONNOE K-ROZHDENIE V RASPADE TYAZHELYKH GIPER-YADER. (Muon K-Production in the Heavy Hypernuclear Decay). S. Gershtein and B. Pontekorvo (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems and Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 6p. Dep.(mn).

It is shown that processes in which muons are produced in the discrete state of μ-mesic atoms and in the states of the continuous spectrum have comparable probabilities. (auth)

27149 (JINR-P-1999) O VRASHCHENII PLOSKOSTI POLYARIZATSII γ-KVANTOV PRI PROKHOZHDENII CHEREZ POLYARIZOVANNUYU ELEKTRONNUYU MISHEN. (Rotation of the Polarization Plane of Gamma Quanta in Passing Through a Polarized Electron Target). V. G. Baryshevskii and V. L. Lyuboshits (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics and Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1965. 6p. Dep.(mn).

It is shown that, when gamma quanta pass through a polarized electron target, rotation of the polarization plane occurs. This phenomenon characterizes the energy range in which the ordinary magnetic rotation of the polarization plane is absent. (auth)

27150 (JINR-P-2021) OB ASIMPTOTICHESKIKH I POROGOVYKH ZNOCHENIYAKH AMPLITUD RASSEYANIYA V NEKOTORYKH STATICHESKIKH MODELYAKH. (Asymptotic and Threshold Values of the Scattering Amplitudes in Some Static Models). R. Vit (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 11p. Dep.(mn)

The Phragmén-Lindelöf theorem is used to investigate the asymptotic behavior of the scattering amplitudes for the neutral pseudoscalar static model and the Chew-Low theory. Some information about the threshold and asymptotic values of the amplitudes is obtained with the aid of the argument principle. (auth)

27151 (JINR-P-2022) O NEKOTORYKH SVOISTOAKH AMPLITUDY RASSEYANIYA VPERED PRI BOL'SHCHIKH ENERGIYAKH. (Some Properties of the Forward Scattering Amplitude at High Energies). R. Vit (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 10p. Dep.(mn).

The Phragmén-Lindelöf theorem and the argument principle are used to consider the connection between the high-energy behavior of Re T(s,O) and Im T(s,O). (auth)

27152 (JINR-P-2027) MODELIROVANIE ROZHDENIYA I RASPADA RESONANSOV. (Simulating the Production and Disintegration of Resonances). V. E. Komolova and G. I. Kopylov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1965. 14p. Dep.(mn).

Simulated backgrounds of resonance states were programmed and new resonances found. A multiple production and decay system expanded to various production conditions was used for calculating the distributions by the effective decay-product masses. (R.V.J.)

27153 (JINR-P-2034) O KLASSIFIKATSII MEZONNYKH REZONANSOV S VYSSHIMI SPINAMI V TEORII SIMMETRII SU(6). (On the Classification of High Spin Meson Resonances in the SU(6) Symmetry). Dao-Wong-Duc and Pham-Qui-Tu (Joint Inst. for Nuclear Research,

Dubna (USSR). Lab. of Theoretical Physics). 1965. 7p. Dep.(mn).

A 189-plet in SU(6) symmetry is considered. The values of the mixing parameters are obtained. The mass splitting is studied. (auth)

27154 (JINR-P-2058) A-CHETNOST I Sp 6 SIMMETRIYA. (A-Parity and Sp 6 Symmetry). B. V. Struminskii (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 4p. Dep.(mn).

An interpretation of the A-parity of Bronzan and Low is given in the framework of the Sp(6) symmetry of strong interactions. (auth)

27155 (JINR-P-2061) SU(6)-SIMMETRIYA V SIL'NYKH I ELEKTROMAGNITNYKH VZAIMODEISTVIYAKH ELEMENTARYNKH CHASTITS. (SU(6) Symmetry in Strong and Electromagnetic Interactions of Elementary Particles). V. G. Kadyshevskii, R. M. Muradyan, and Ya. A. Smorodinskii (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 60p. Dep.(mn).

A systematic review of SU(6) symmetry applications to strong and electromagnetic interactions of elementary particles is given. (auth)

27156 (JINR-P-2066) O RELYATIVISTSKOI ZADACHE TREKH TEL. II. (On Relativistic Three-Body Problem. [Part] II). D. Stoyanov and V. P. Shelest (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 14p. Dep.(mn).

Equations were obtained for the matrix elements of the scattering amplitudes in the relativistic three-body problem. The approximations for these elements were considered in the cases of strong and weak couplings in the two-body bound state. (auth)

27157 (JINR-P-2071) O PREDELE PRIMENIMOSTI TEORII VOZMUSHCHENII DLYA SLABYKH VZAIMODEISTVII. (On Limit of Applicability of Perturbations for Weak Interactions). Pham Qui Tu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 10p. Dep.(mn).

Using the unitarity condition, upper estimates have been obtained for the boundary of the energy region where the perturbation theory is applicable for weak interactions. (auth)

27158 (JINR-P-2141) RELYATIVISTSKI-INVARIANTYNE URAVNENIYA DLYA SOSTAVNYKH CHASTITS I FORMFAKTORY. II. (Relativistic Invariant Equations for Composite Particles and the Form Factors. [Part] II). N. N. Bogolyubov, V. A. Matveev, Nguyen Van Hieu, D. Stoyanov, B. V. Struminskii, A. N. Tavkhelidze, and V. P. Shelest (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 12p. Dep.(mn).

Relativistic invariant equations for composite particles were used to obtain the electromagnetic and weak formfactors as well as the amplitudes of radiative decays of vector and pseudovector mesons and baryon resonances. (auth)

27159 (LA-3126) PION-NUCLEON ELASTIC SCATTERING EXPERIMENTS WITH HIGH INTENSITY MESON BEAMS. Nelson Jarmie (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Aug. 1964. Contract W-7405-eng-36. 29p. Dep.; $2.00(cy), 1(mn) CFSTI.

Pion-nucleon elastic scattering experiments that should be useful to do with a high-current proton linear accelerator ("Meson Factory") are studied in detail. Counting rate calculations are made for experiments to measure the pion-proton differential cross section, polarization, and rotation parameters at 300-Mev pion energy. Errors, backgrounds, duty cycles, corrections, and costs are studied in detail. An experiment to measure the pion-neutron interaction is briefly investigated. The results are compared with present research programs and indicate that experiments in elastic pion-nucleon scattering can be done with a high-intensity meson beam cleanly, quickly, economically, and with greatly improved precision. The small size of the beam of the high-intensity source combines with the high intensity to produce notable advantages. The contribution to the phenomenological understanding of the pion-nucleon interaction should be significant. (auth)

27160 (LNF-64/67(Rev.)) CALCOLO DELLA EFFICIENZA DI RIVELAZIONE DELLA Λ, PRODOTTA NELLA REAZIONE $\gamma + p = K^+ + \Lambda$, CON UN TELESCOPIO DI CONTATORI. (Calculations for the Efficiency of Detection of Λ Production in the Reaction $\gamma + p \rightarrow K^+ + \Lambda$ by a Counter Telescope). Note No. 267. M. A. Locci, M. Nigro, and G. Verri (Laboratori Nazionali di Frascati, Comitato Nazionale per l'Energia Nucleare (Italy)). Dec. 22, 1964. 15p. Dep.(mn).

The statistical Monte Carlo method was used for the calculation of the geometric efficiency of a counter telescope in the detection of protons from Λ decay. The method in which the calculation was imposed was described by summarizing various phases of the program and presenting a block diagram for the input and output data. A sample calculation is made and compared for the experimental data. (J.S.R.)

27161 (NEVIS-131) THE PROPERTIES OF THE ω AND φ MESONS (thesis). David C. Miller (Nevis Labs., Columbia Univ., Irvington-on-Hudson, N. Y.). Apr. 1965. Contract AT(30-1)-1932. 80p. (CU-237; R-489). Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Antiprotons from the AGS were stopped in the Brookhaven National Laboratory-Columbia 30-in. hydrogen bubble chamber in order to study the properties of the ω and φ mesons. In particular, reactions in which kaons were produced were examined. From a study of the reaction $\bar{p} + p \rightarrow K^+ + K^- + \omega$, $\omega \rightarrow \pi^+ + \pi^- + \pi^0$, the mass and natural width of the ω were measured to be 785.6 ± 1.2 Mev and 13.4 ± 2.0 Mev. A study of other channels has allowed an estimate of the following branching ratios: 1) $\omega \rightarrow \text{neutrals}/\omega \rightarrow \pi^+ + \pi^- + \pi^0 = (13.0 \pm 3.5)\%$, and 2) $\omega \rightarrow \pi^+ + \pi^-/\omega \rightarrow \pi^+ + \pi^- + \pi^0$ is less than 3.5%. The mass and natural width of the φ meson were determined from the reaction $\bar{p} + p \rightarrow \phi + \pi^+ + \pi^-$, $\phi \rightarrow K^+ + K^-$. The results are $M_\phi = 1018.6 \pm 0.5$ Mev and $\Gamma_\phi \rightarrow K^+ + K^- = 3.5 \pm 1.0$ Mev. From a study of the neutral and charged kaon final states, the quantum numbers of the φ meson, T = 0, C = −1, G = −1, P = −1, 1 = odd were confirmed. (auth)

27162 (NP-14909) DIFFUSION DES ELECTRONS DE HAUTE ENERGIE SUR LE DEUTERON (theses). (Scattering of High-Energy Electrons on Deuterons (thesis)). Bernard Grossetete (Paris Univ., Orsay (France). Faculté des Sciences). 1964. 137p. Dep.(mn).

The theory of the scattering is explored first for the general case, then elastic scattering and the concept of the form factor, and, in conclusion, inelastic scattering. The experimental equipment used in the study of the scattering of high-energy electrons on deuterons is described. The different corrections used to treat the crude results in order to obtain data directly interpretable by the theory are discussed. The errors are then analyzed. The results are discussed in detail with emphasis on the form factors. (J.S.R.)

27163 (PAN-552/VI) RELATIVISTIC KINEMATICS OF NEW MODELS OF MULTIPLE MESON PRODUCTION AND SOME RELATED TOPICS. T. Coghen (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research). Aug. 1964. 69p. Dep.

A review of formulas useful in the analysis of high energy events is given, and some procedures are described. Formulas are given concerning the kinematics of collisions and angular distributions and their transformation, and some multiple production models are discussed. (auth)

27164 (SC-RR-65-141) TRANSMISSION OF X RAYS THROUGH AIR. James H. Renken (Sandia Corp., Albuquerque, N. Mex.). Apr. 1965. Contract [AT(29-1)-789]. 41p. Dep.; $3.00(cy), 1(mn) CFSTI.

The transport equation describing the transmission of photons through a medium which both scatters and absorbs radiation is considered. After specializing to the case of a point source emitting isotropically into a homogeneous medium, a solution for the photon density as a function of various parameters is obtained by using the polynomial method of Fano and Spencer. Sample numerical results are given. (auth)

27165 (TID-21734) CHARGE EXCHANGE SCATTERING OF LOW-ENERGY K^- MESONS IN HYDROGEN. Technical Report No. 441. Gerald S. Abrams and Bice Sechi-Zorn (Maryland. Univ., College Park). Mar. 1965. Contract AT(40-1)-2904. 21p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The momentum dependence of the cross section for the reaction $K^- + p \rightarrow \bar{K}^0 + n$ was determined. The data are analyzed in terms of an effective range approximation to the K^--p phase shifts. A comparison is made to other studies of low energy K^--p interactions, and the data used to infer the existence of a $\bar{K}N$ S-wave bound state. (auth)

27166 (UCRL-7523) POLARIZED PIONS. W. A. Perkins (Lawrence Radiation Lab., Univ. of California, Livermore). Feb. 9, 1965. Contract W-7405-eng-48. 19p. Dep.; $1.00(cy), 1(mn) CFSTI.

The possibility that all pions have spin 1 is considered. The spin-zero assignment for charged pions is based mainly on a detailed balance argument involving the reaction $p + p \rightarrow \pi^+ + d$, while for neutral pion the argument is based on its decay into two photons. It has been previously noted that the detailed balance argument is invalid if the pions are completely polarized in the production reactions, and that such polarization is possible only in longitudinal mode with zero spin along the direction of propagation. A particular model of the pion is discussed in which the pion is considered as a composite particle composed of two spin-½ particles. The particle so formed is longitudinally polarized with zero spin along the direction of propagation and exists only in this spin state. The longitudinal polarization is in agreement with the observed polarization from π-μ decay. The argument against a spin-1 particle decaying into two photons was also examined, but still appears valid. Some experimental implications of the theory are discussed. (auth)

27167 (UCRL-11333) A MEASUREMENT OF $d\sigma(0)/d\Omega$ FOR THE REACTION $\pi^- + p \rightarrow \pi^0 + n$ AT 900 Mev IN THE 72-INCH HYDROGEN BUBBLE CHAMBER. Alan Natapoff and Vo Xuan Bang (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 13, 1964. Contract W-7405-eng-48. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A low-statistics measurement of $d\sigma(0)/d\Omega$ for the reaction $\pi^- + p \rightarrow \pi^0 + n$ at 1.03 Bev/c in the 72-inch hydrogen bubble chamber is described. The π^- beam comes from the Bevatron, and the secondary neutrons are detected when subsequent elastic scatters $n + p \rightarrow n + p$ yield visible stopping protons. The real events were separated from the spurious by a Boolean algebraic method that reduced the set of all events to a sum of a small number of physically significant sets. The residual background fraction was estimated at 10% by a computer simulation technique using the known beam distribution and a pure sample of background events. The bubble chamber, so used, detects about 5% of the secondary neutrons emitted in the charge-exchange reaction. There were 12 experimental events in three intervals lying in the range $0.84 \leq \cos \theta_{\pi\pi}^{c.m.} \leq 0.96$. A zero-constraint, least-squares fit of the distribution yielded the estimate $d\sigma^{ce}(0)/d\Omega = (3.65 \pm 1.93)$mb/sr. This result is consistent with the predictions based on the dispersion relations. (auth)

27168 (UCRL-12030-T) CUSPOLOGY AND FIVE-BODY REACTION IN THE LOW 20-Mev ENERGY REGION. W. Brian DeFacio (Lawrence Radiation Lab., Univ. of California, Livermore). Aug. 18, 1964. Contract W-7405-eng-48. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Using the concepts of effective range theory and cuspology a recent experiment on a threshold anomaly in the elastic cross section of neutrons from the neutron-alpha reaction is investigated and it is shown that this anomaly can be explained as a combination of a resonance in the $^2D(3/2)$ state of the neutron-alpha system together with a spin coupling to the $^4S(3/2)$ state of the deuteron-triton system. (auth)

27169 ELECTROMAGNETIC RADIATION AND DIFFRACTION IN ANISOTROPIC REGIONS. L. B. Felsen (Polytechnic Inst. of Brooklyn). Acta Phys. Polon., 27: 197-216(Feb. 1965).

The thorough understanding of the propagation characteristics of plane waves in homogeneous and sectionally homogeneous anisotropic regions is of prime importance in the solution and interpretation of radiation and diffraction problems which may be obtained by a synthesis of plane wave results. The nature of plane wave propagation in a homogeneous, lossless anisotropic region may be inferred conveniently from the refractive index plots which highlight in a suitable manner the different orientations of the wave normal (phase propagation) and ray (energy propagation) vectors. These plots may also be employed in the imposition of boundary conditions at a plane interface between two different media, and one frequently used method of ray tracing in a slowly varying medium actually exploits this property. Ray tracing procedures which have been employed successfully in the theory of ionospheric wave propagation may also be applied to the study of radiation from localized current distributions provided that the propagating ray amplitudes excited by the source (either primary as in an antenna, or secondary, as on an obstacle) are known. The latter information is furnished by the asymptotic analysis of the problem of radiation from an arbitrarily oriented electric or magnetic current dipole in an infinite, homogeneous region, the solution for which has recently become available and is described. While the modified ray tracing technique is useful for the prediction of the fields in slowly varying or sharply bounded anisotropic regions, it yields no information about propagation phenomena which are not explainable in simple geometric-optical terms. Included among these are interface effects giving rise to surface waves, leaky waves and lateral waves, and their influence in an anisotropic configuration may be more pronounced than in an isotropic one. A good deal of insight has already been gained from certain special problems which have been solved, but work remains to be done even for such a simple arrangement as a source exciting a homogeneous gyrotropic half space, with the gyrotropic axis inclined arbitrarily. The orientation of the optic axis with respect to the boundaries of the medium has a marked influence on the boundary wave phenomena so that this aspect deserves careful exploration. The analytical difficulties are compounded further when obstacles are introduced into an anisotropic medium. Only certain simple problems have been solved—primarily in uniaxially anisotropic and specially arranged gyrotropic regions—but the interpretation of these results has led to an understanding of what may be expected under more general conditions. It appears that the rays, and not the wave normals, in the incident field are instrumental in the definition of illuminated and shadow zones and also in the launching on large objects of diffracted rays associated with such structural effects as surface curvature, edges, corners, etc. These latter contributions are again expected to depend strongly on the medium parameters and the orientation of the optic axis, thereby presenting another class of canonical problems which must be investigated before the quantitative understanding of scattering in anisotropic media will be as complete as in the isotropic case. (auth)

27170 S-MATRIX IN TERMS OF CURRENT OPERATOR. Jan Rzewuski (Warsaw Univ. and Inst. of Physics, Polish Academy of Sciences, Warsaw). Acta. Phys. Polon., 27: 235-43(Feb. 1965).

A functional formulation of the S-matrix theory is presented in which this matrix is expressed in terms of current operators. The connection with the functional formulation leading to an expression of the S-matrix in

terms of field operators is investigated. A proof of equivalence of the two formulations is given. (auth)

27171 GENERAL RULES OF ISOSPIN CROSSING. Andrzej Kotanski (Jagellonian Univ., Krakow). Acta Phys. Polon., 27: 351-3(Feb. 1965).

Diagrams and rules for the construction of isospin crossing matrices in elementary particle interactions or decay are discussed. (C.E.S.)

27172 UNITARY SYMMETRY AND $\Delta T = \frac{1}{2}$ RULE. W. Krolikowski (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw and Warsaw Univ.). Acta Phys. Polon., 27: 355-7(Feb. 1965).

Matrix operations supplemental to the paper "Unitary Symmetry and the $\Delta T = \frac{1}{2}$ Rule" (NSA 19: 18758) are presented. (C.E.S.)

27173 REGGE POLE IN RELATIVISTIC SCATTERING ON COULOMB POTENTIAL. L. Burlacu (Univ. of Bucharest). Analele Stiint. Univ. "A. I. Cuza," Iasi, Sect. I, 10: 1-6(1964). (In Rumanian)

The analytic properties of the S matrix in the plane of the complex angular momenta are studied in the relativistic coulomb scattering of the particles of spin $\frac{1}{2}$. This work is essentially an extension of work on the coulomb scattering in Schroedinger theory and of the work regarding the same problem for Klein-Gordon theory. (auth)

27174 ON RESONANCE DENSITY IN SCATTERING ON BOUND PARTICLES. S. N. Sokolov and B. N. Zakhariev (Joint Inst. for Nuclear Research, Dubna, USSR). Ann. Physik (7), 15: 5-11(1965).

The emergence of frequent resonances is demonstrated on a simple model for the case in which a particle is scattered on a potential well occupied by another particle. The result obtained shows that the frequent resonances in the cross section for slow-neutron scattering on nuclei can be understood on the basis of a considerably simpler mechanism of the reaction than the transfer of the energy of an incident particle to all the nucleons in the nucleus. (auth)

27175 ON VIRTUAL EXCITATIONS OF A COMPOUND PARTICLE. B. N. Zakhariev and S. N. Sokolov (Joint Inst. for Nuclear Research, Dubna, USSR). Ann. Physik (7), 15: 183-91(1965).

The one-dimensional motion of three interacting particles is considered for the case in which two of them form a bound state (compound particle). For the particular case in which the excitation energy of the compound particle grows quadratically, the effect of the infinite number of virtual excitations is investigated. It is shown that the population of the higher states is in inverse proportion to the cube of the excitation energy and the neglect of the states higher than the s^{th} one leads to an error of the order $(1/s^3)$. Besides, it is proved that the system of equations which takes into account all the virtual excitations of the compound particle can be solved by the Fredholm method. (auth)

27176 MODULATION OF ELECTROMAGNETIC WAVES BY ACOUSTIC WAVES IN A PLASMA. II. EFFECTS IN THE IONOSPHERE AND ROCKET EXHAUSTS. M. S. Sodha and P. K. Kaw (Indian Inst. of Tech., Hauz Khas, New Delhi, India). Can. J. Phys., 43: 965-8(May 1965).

The magnitude of an electromagnetic wave through a plasma in which an acoustic wave is present is investigated for the ionosphere when the exhaust from a rocket may interfere. A mathematical discussion concludes that signals may be modulated undesirably by rather low levels of acoustic noise. Laboratory experiments are required for confirmation. (AECL)

27177 METHODS OF APPROXIMATION FOR PROCESSES WITH TWO VIRTUAL PHOTONS. Jean-Claude Le Guillou (Institut Henri Poincare, Paris). Compt. Rend., 260: 2430-3(Mar. 1, 1965). (In French)

The connection between the approximation methods proposed in a previous article (Compt. rend. 259, 2793(1964)) for processes with two virtual photons and the double application of the covariant versions of the Williams-Weizsacker method for processes with exchange of a single virtual photon was established. For these latter processes, an extension of the Williams-Weizsacker covariant methods is given. (tr-auth)

27178 DIFFRACTIVE RADIATION OF FAST PARTICLES. M. L. Ter-Mikaelyan and B. V. Khachatryan (Erivan State Univ.). Dokl. Akad. Nauk Arm. SSR, 40: 13-18 (1965). (In Russian)

A simple method, analogous to that for calculating light-wave diffraction using the Huygens principle, is presented for calculating exactly the radiation emitted during the passage of fast charged particles through screens and apertures, when the electromagnetic field of the particle is equivalent to a set of plane waves. It is assumed that the incident particle wavelength is much less than the dimensions of the aperture and the angles of divergence from the primary direction of the distribution are small. The electric fields and the angular distributions of the emitted electromagnetic waves are derived for the cases of a charged particle passing through a circular aperture in an infinite screen at a given distance from the aperture center and a charged particle passing through a slot in an opaque screen. (M.J.T.)

27179 EFFECT OF ION ENGINE EXHAUST ON THE RADIATION FIELD OF A DIPOLE ANTENNA. PART I. INFINITE SLAB MODEL FOR THE EXHAUST ION BEAM. A. R. M. Rashad (Univ. of Detroit). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 2, 12-18 (Apr. 1965).

A theory of the effect of an ion rocket engine exhaust on the radiation pattern of a dipole antenna is presented. The electromagnetic equations are combined with those describing the exhaust plasma beam to calculate its equivalent effective dielectric constant. The beam is represented by an infinite slab of a homogenous plasma medium, as is usually considered in space-charge neutralization studies of this type of engine. The equations of propagation of electromagnetic waves through the beam medium are used to calculate the total dipole radiation field. The method of steepest descent is applied for the evaluation of the integrals. It is found that the dipole radiation pattern depends greatly on the beam characteristic parameters. (auth)

27180 EFFECT OF ION ENGINE EXHAUST ON THE RADIATION FIELD OF A DIPOLE ANTENNA. PART II: CYLINDRICAL CONFIGURATION FOR THE ENGINE EXHAUST BEAM. A. R. M. Rashad (Univ. of Detroit). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 2, 19-22(Apr. 1965).

A cylindrical configuration is used to represent the engine exhaust beam. The dipole, considered as a linear current source, is transformed by means of a Fourier series to an equivalent cosinusoidally distributed current sheet surrounding the beam. A radiation pattern function is presented to give the azimuthal beam synthesis of the dipole. It is found that the antenna radiation pattern is affected seriously by the presence of the exhaust beam. Plasma waves in the exhaust beam are found to be excited by the dipole field. The Boltzman and Poisson equations are used to investigate the existence and nature of these waves. (auth)

27181 THE THEORY OF STRONG INTERACTIONS AND COSMIC RAYS. E. L. Feinberg and D. S. Chernavskii (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1730-40(Nov. 1964). (In Russian)

A review of recent theoretical work in the field of strong interactions is presented, with general suggestions on experiments that may serve to advance theory or verify different hypotheses. The method of Regge poles and the one-meson (one-particle) approximation (based on consideration of a certain class of Feynman graphs), are described, including the multiperipheral model and their agreement with experiment. The Regge pole method is characterized as an attempt at a universal description of all elastic strong interactions. The one-particle exchange model and the one-meson approximation are, of course, concerned primarily with glancing or peripheral collisions, the opposite extreme

from central encounters. The relation between elastic and quasielastic collisions is discussed in the formalism of the above-mentioned methods. An evaluation of the significance of hydrodynamic theory, particularly, the peripheral-hydrodynamic model, in treating strong interactions is presented. Some of the deductions from theory that have been substantiated by experiment are given, and promising lines for further experimentation are suggested. It is noted that accelerator-based experiments in the next few decades will necessarily be limited to the energy range below 30 to 70 Bev, unless there is an unexpected breakthrough in accelerator design. Although the maximum available energy already exceeds the threshold for production of most particles, this does not mean that experimental study of cosmic radiation has become valueless or that it is needless to attempt to develop even higher energy particle accelerators. Some space is devoted to the fire-ball model and the desirability of further investigation in this area, for instance, to determine whether the number or/and size of the fire-ball clusters increase(s) with increasing energy. (ATD)

27182 EXPERIMENTAL INVESTIGATION OF NUCLEAR INTERACTIONS AT ENERGIES FROM 10^{11} TO 10^{13} ev. N. L. Grigorov, N. A. Dobrotin, G. B. Zhdanov, and Zh. S. Takivaev (Moscow State Univ.; Lebedev Inst. of Phys. Moscow; and Inst. of Nuclear Physics, Academy of Sciences, Kazakh, SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1741-50 (Nov. 1964). (In Russian)

A review is presented of recent experimental work on nuclear processes occurring at very high energies, specifically, in the 10^{11} to 10^{13} ev range. It is noted that nuclear processes in this energy range are characterized by very slow variation of their characteristics (cross section, etc.) with energy, which makes it imperative to encompass a wide energy interval in order to discover trends and regularities. Mention is made of some theoretical evaluations as well as confirming or independent experimental studies by means of pellicle stacks, ionization calorimeters, various counter and chamber arrays, and spark chambers (the merits of the last are stressed), aimed at determining gamma spectra, particle distributions, shower particle spectra, etc. The fire-ball model is discussed in connection with some of the briefly described experimental results and theoretical hypotheses. Mainly, only fragmentary or general data are given. Among the experimental problems suggested for further study in the immediate future are measurement of the inelasticity coefficient and its variation in magnitude in N–N interactions, determination of the variation of the inelasticity coefficient and interaction cross section with the atomic number in nucleon-nucleus interactions, clarification of the role played by the fire-ball mechanism in nucleon-nucleus and π–N interactions, determination of the significance of the process of pion production via decay of isobars and comparison of neutral and charged pion production processes, determination of the relative importance of central collision processes interactions at different energies, and determination of the fraction of different strange particles created at different primary particle energies. It is hoped that solutions to some of these problems will be provided by the new cosmic-ray research equipment now being installed at mountain altitudes in the Soviet Union. These installations consist of large Wilson chambers in a magnetic field and several trays of ionization calorimeters. The largest installation of this type is now being constructed in the Georgian SSR at an elevation of 2200 meters; this will be equipped with 2×2 m Wilson chambers and a 1000-ton electromagnet. (ATD)

27183 CHARACTERISTIC CURVES FOR 10^{11}-10^{14} ev SHOWERS. Zh. S. Takivaev and L. A. San'ko (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1767-9(Nov. 1964). (In Russian)

An analysis of contradictions of a model for excited nucleons and a fire-ball model with experimental data on jets resulted in a model for intermediate resonons and baryon pairs. Certain characteristics of jets are discussed from the viewpoint of the formation of shower particles principally from intermediate π-π interaction with single-pion exchange. The experimental data considered covers a wide range of primary energies. (ATD)

27184 PASSAGE OF HIGH-ENERGY NUCLEONS THROUGH THE ATMOSPHERE AND THE FORMATION OF MESONS. L. T. Baradzei, V. I. Rubtsov, Yu. A. Smorodin, and M. V. Solov'ev (Moscow State Univ. and Lebdev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1807-11(Nov. 1964). (In Russian)

The spectrum of the primary nucleons in meson generation becomes sharper than the cascade spectra. The absorption of the active nuclear component in the terrestrial atmosphere may be determined by the ratio of the energy of secondary particles to the energy of the primary component, neglecting the magnitudes of these energies. The flux of the active nuclear component in the atmosphere at a depth t may be computed by using formulas for high energies and comparing the results with spectra of the nuclear cascades. The part of the energy transferred to the electron-photon component during the nuclear interaction is $0{,}22^{1.7}$. This result makes it possible to assume that the generation of mesons (π^0) with energies of 10^{11} to 10^{13} ev is proportional to the energy of active nuclear particles. The formation of mesons ($\pi^\pm$) may resemble the formation of mesons (π^0), and the probability of all generated pions is $0{,}26^{1.7}$. An analysis of the data obtained shows that mesons (π^0) are associated with showers whose energy is 10 times that of the meson (π^0) energy. (ATD

27185 CONTRIBUTION TO THE THEORY OF DEUTERON SCATTERING BY ALPHA PARTICLES. V. A. Sergeev (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 105-12(Jan. 1965). (In Russian)

The p-wave scattering phases for deuterons on α particles were calculated for deuteron energies to 4.6 Mev by a variational method with distortion of the deuteron wave function taken into account. The interaction between a nucleon and the α particle was described by a Gaussian potential, and calculations were performed both with the parameter values employed by Sack, Biedenharn, and Breit (Phys. Rev. 93: 321, 1954) and with those of van der Spuy (Nucl. Phys. 1: 381, 1956). The nucleon-nucleon interaction was represented by a 50.89 Mev deep Gaussian well with radius 1.82 fermi. Calculations were also performed with a stepped rectangular potential well. The calculations were performed by the variational method of Kohn (Phys. Rev. 74: 1763, 1948) and by that of Rubinow (Phys. Rev. 98: 183, 1955). Both methods gave nearly the same results. The effect of deuteron distortion was to increase the effective interaction and the scattering phases. The p-wave scattering phases were positive, increased with increasing deuteron energy, and showed considerable dependence on the total angular momentum quantum number. This is not in good agreement with the phase analysis of the experimental data performed by Galonsky and McEllistrem (Phys. Rev. 98: 590, 1955) which showed the p-wave phase to be negative for deuteron energies between 3 and 4.6 Mev. The experimental phase, however, is positive at energies near 1 Mev, in agreement with the present calculations. Calculations with the rectangular potential well of Gammel, Hill, and Thaler (Phys. Rev. 119: 267, 1960) lead to negative phases over the full range of energies considered here, and this potential is accordingly regarded as unsatisfactory. In order to obtain better understanding it would be desirable to calculate other properties of the $n + p + \alpha$ system and to improve the phase analysis of d-α scattering. (ATD)

27186 SCATTERING OF NEUTRINOS AND ANTINEUTRINOS BY ELECTRONS WITH SPIN CORRELATIONS TAKEN INTO ACCOUNT. B. K. Kerimov and Yu. I. Romanov (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 128-32(Jan. 1965). (In Russian)

The scattering cross sections of neutrinos and antineutrinos by free electrons are calculated, and formulas for the polarization of the recoil electrons are derived. The calculation is based on the four component Dirac neutrino with mixed (V,A) interaction of the ($e\nu$) (νe) type. The cross sections are derived by appropriate substitutions into the

formula previously derived by Kerimov for the matrix element of the weak four-fermion (V,A) interaction between four longitudinally polarized fermions. The polarization of the recoil electrons is large and reaches 90 to 97% for 50 Mev incident neutrinos. The recoil electrons from neutrino scattering have helicity of the same sign as that of the incident neutrinos; those from antineutrino scattering have helicity of the opposite sign from that of the antineutrino. It is concluded that observations of spin correlations in νe and $\bar{\nu}e$ scattering would make it possible to resolve the question of the existence of a direct electron-neutrino interaction and to test the predictions of the four component Dirac neutrino theory with regard to the helicity of the two neutrinos and the two antineutrinos. (ATD)

27187 CALCULATION OF ELASTIC SCATTERING AND RADIATIVE PROCESSES IN A NEUTRON-PROTON SYSTEM WITH NONLOCAL INTERACTION. B. B. Dotsenko and V. M. Salasyuk (Kiev State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 339-43(Feb. 1965). (In Russian)

A brief review is given of the literature relating to nonlocal nucleon interactions and the repulsive nucleon core. With the use of a separable nonlocal potential of the Yamaguchi-Wheeler type, calculations are made (with neglect of tensor forces) of the low energy (to 15 Mev) proton-neutron scattering cross section and the deuteron photodisintegration cross section for γ-ray energies to 50 Mev. From comparison of the calculated cross sections with experimental data in the literature, it is concluded that the nonlocal potential is in satisfactory agreement with experiment and that the repulsive core exerts a small but definite influence. (ATD)

27188 RELATIVISTIC FORMULATION OF THE LIFETIME MATRIX IN THE POTENTIAL THEORY OF COLLISION. Tran Trong Gien (Ohio Univ., Athens). J. Math. Phys. (N. Y.), 6: 671-6(May 1965).

The lifetime matrices for collision processes as described by the Klein-Gordon and Dirac equations are formulated. The results obtained are exactly the same as in the case of a collision described by the Schroedinger equation. This gives us a consistent operator theory for the collision lifetime in the case of potential scattering. (auth)

27189 A SET OF HARMONIC FUNCTIONS FOR THE GROUP SU(3). Mirza A. B. Beg (Rockefeller Inst., New York) and Henri Ruegg. J. Math. Phys. (N. Y.), 6: 677-82 (May 1965).

A set of harmonic functions carrying all the irreducible representations of the group SU(3) is constructed. Some features of these functions are discussed in detail. (auth)

27190 OPERATORS THAT LOWER OR RAISE THE IRREDUCIBLE VECTOR SPACES OF U_{n-1} CONTAINED IN AN IRREDUCIBLE VECTOR SPACE OF U_n. John G. Nagel and Marcos Moshinsky (Universidad de Mexico, Mexico City). J. Math. Phys. (N. Y.), 6: 682-94(May 1965).

Operators that lower or raise the irreducible vector spaces of a semisimple subgroup of a semisimple Lie group contained in an irreducible vector space of the group are defined. The lowering and raising operators for the canonical subgroup U_{n-1} of the unitary group U_n are determined. With the help of these operators, which are polynomial functions of the generators of U_n, and the corresponding operators for the subgroups in the canonical chain $U_n \supset U_{n-1} \supset \ldots \supset U_2 \supset U_1$ one can obtain, in this chain, the full set of normalized basis vectors of an irreducible vector space of U_n from any given normalized basis vector of the vector space. In particular one can obtain, using only the lowering operators, the set of basis vectors from the basis vector of highest weight of the vector space. This result is of importance in applications to many-body problems and in the determination of the Wigner coefficients of U_n. (auth)

27191 ALGEBRAIC TABULATION OF CLEBSCH-GORDAN COEFFICIENTS OF SU_3 FOR THE PRODUCT $(\lambda,\mu) \otimes (1,1)$ OF REPRESENTATIONS OF SU_3. J. G. Kuriyan, D. Lurie, and A. J. MacFarlane (Univ. of Rochester, N. Y.). J. Math. Phys. (N. Y.), 6: 722-33(May 1965).

An algebraic tabulation is made of the Clebsch-Gordan (CG) coefficients of SU_3 which occur in the reduction into irreducible representations of the direct product $(\lambda,\mu) \otimes (1,1)$ of irreducible representations of SU_3. Full explanation is made of the method of handling the complications associated with the possible double occurrence of the representation (λ,μ) itself in the direct product. The phase convention employed is an explicitly stated generalization of the well-known Condon and Shortley phase convention for SU_2. The relation of the CG coefficients associated with the direct product $(1,1) \otimes (\lambda,\mu)$ to those coefficients already mentioned is also exhibited. (auth)

27192 TENSOR METHODS AND A UNIFIED REPRESENTATION THEORY OF SU_3. N. Mukunda and L. K. Pandit (Univ. of Rochester, N. Y.). J. Math. Phys. (N. Y.), 6: 746-65(May 1965). (UR-875-38)

Starting with irreducible tensors, an explicit construction of orthonormal basic states is developed for an arbitrary unitary irreducible representation (λ,μ) of the group SU_3. A knowledge of the simple properties of the irreducible tensors can then be exploited to obtain a variety of results, which ordinarily require more abstract algebraic methods for their derivation. As illustrative applications, Biedenharn's expressions for the matrix elements of the generators of SU_3 are derived, the matrix elements of octet-type operators for the case $(\lambda,\mu) \rightarrow (\lambda,\mu)$, are computed, and an explicit unitary transformation connecting the isospin and the U-spin states in any arbitrary irreducible representation is developed. (auth)

27193 EXACT BOOTSTRAP SOLUTIONS IN SOME STATIC MODELS OF MESON-BARYON SCATTERING. Kerson Huang and Francis E. Low (Massachusetts Inst. of Tech., Cambridge). J. Math. Phys. (N. Y.), 6: 795-816 (May 1965). (MIT-2098-87)

The exact bootstrap solutions to four well-known models of meson–baryon scattering are studied in the nonrecoil, one-meson approximation. The models are the neutral scalar theory, the charged scalar theory, the symmetric scalar theory, and the neutral pseudoscalar theory. A bootstrap solution is defined to be a solution satisfying Levinson's theorem of potential scattering. It is found that the existence of a bootstrap solution depends crucially on the high-energy conditions, which enter the problem through a cutoff function and through subtractions in the dispersion relations. In all the models considered there is no bootstrap solution with no subtraction. With one subtraction there exists more than one bootstrap solution. However, the requirements that the meson–baryon coupling constant should be different from zero, and there should be no inelastic threshold below the elastic threshold, render the bootstrap solution unique. Positions of bound states and their coupling constants depend on two arbitrary parameters, which may be taken to be the cutoff momentum and the subtraction constant. (auth)

27194 COMPACTIFICATION OF MINKOWSKI SPACE AND SU(3) SYMMETRY. Robert Hermann (Argonne National Lab., Ill. and Northwestern Univ., Evanston, Ill.). J. Math. Phys. (N. Y.), 6: 817-19(May 1965).

Several ideas from the geometric side of Lie group theory are presented that may be relevant to the search for groups containing the internal and Poincaré group symmetries. (auth)

27195 PROBLEM OF SUBTRACTIONS IN POTENTIAL SCATTERING. D. Bessis (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). J. Math. Phys. (N. Y.), 6: 820-4(May 1965).

The problem of subtractions in potential scattering theory is studied. It is shown that the single spectral functions can be obtained by analytic continuation of the Mellin transform of the double spectral function. The N/D method could thus be avoided, in principle. (auth)

27196 NOTE ON NON-LANDAU SINGULARITIES. Paul Federbush (Massachusetts Inst. of Tech., Cambridge). J. Math. Phys. (N. Y.), 6: 825-?(May 1965). (MIT-2098-126)

Some non-Landau singularities are discussed using the

formalism of Fotiadi, Froissart, Lascoux, and Pham. The simple cases of self-energy and vertex diagrams are treated, as well as the sixth-order scattering ladder diagram. (auth)

27197 DISTORTED WAVE APPROXIMATION OF THE HUMBLET-ROSENFELD SCATTERING MATRIX. Tamas Dolinszky. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen, 13: 3-25(1965). (In Hungarian)

The scattering matrix element of the Humblet-Rosenfeld theory is approximated in view of its possible application in the theory of direct interactions. The new DWHR matrix element is analogous but not necessarily equivalent to the DWBA approximation. The exact reaction state is replaced by four different wave functions — two elastic scattering states and two distorted reaction states. The approximated reaction states are characteristic for the treatment and correspond to the actual initial (or final) state combined with the two-term optical potential of the final (or initial) separation. (auth)

27198 GENERATION OF VERY LOW FREQUENCY AND HYDROMAGNETIC EMISSIONS. Neil M. Brice (Defence Research Telecommunications Establishment, Ottawa and Carleton Univ., Ottawa). Nature, 206: 283-4(Apr. 17, 1965).

A comparison was made of the features of very low frequency emissions (found in the frequency range 400 c/s-10 kc/s) and hydromagnetic emissions (0.2-5 c/s) revealed a large number of similarities and some dissimilarities. Both similarities and differences suggest that the generation mechanisms for these two phenomena are essentially the same, with very low frequency emissions being generated by electrons and hydromagnetic emissions by protons. The similarities and differences are listed. (P.C.H.)

27199 CHANGE OF PHOTON SPIN IN COMPTON SCATTERING. Ki Ho Chung. New Phys. (Korea), 4: No. 1, 37-9(1964). (In Korean)

A calculation is given to describe the manner in which a photon with definite spin changes its index in the process of scattering by an electron at rest. In order to utilize the formula obtained by Klein and Nishina, a complex polarization unit vector was introduced for use in expanding the photon wave function $A_n(k)$ in a manifestly covariant form. Two differential cross sections $d\sigma_{++}$ and $d\sigma_{+-}$ were derived and their non-relativistic approximations are given. (auth)

27200 THEORY OF DEUTERON SPLITTING BY SLOW PROTONS. A. A. Anselm and G. S. Danilov (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Phys., 69: 193-203 (July 1965).

Interaction between slow protons (with wavelengths much larger than the range of nuclear forces) and deuterons is considered. In contrast to the theory previously developed for neutron-deuteron scattering (and the splitting of deuterons by neutrons) the problem involves the consideration of the Coulomb interaction of protons. It is shown that the elastic proton-deuteron scattering can be described by the Landau-Smorodinsky formulas for p-p scattering or (in another energy range) by a simple sum of nuclear and Coulomb amplitudes. The amplitude of the $p + d \rightarrow p + p + n$ process can be obtained rather simply from the amplitude of the $n + d \rightarrow n + n + p$ process if the Coulomb corrections $\alpha e^2/\hbar v_t \approx 0.1$ (where v_t is the triplet velocity of the nucleons in a deuteron) are neglected and the total energy of the three particles produced is assumed to be much larger than the absolute magnitude of the virtual singlet nucleon binding energy. (auth)

27201 NON-RELATIVISTIC PROBLEM OF THREE AND FOUR NUCLEONS. V. V. Komarov and Anna M. Popova (Moscow State Univ.). Nucl. Phys., 69: 253-72(July 1965).

The problem of three- and four-nucleon interactions is solved on the basis of non-relativistic field theory. The theory thus developed permits investigation of systems of a larger number of nucleons, which opens a possibility of creating a non-model theory of light nuclei. (auth)

27202 THE ELASTIC SCATTERING OF LOW ENERGY NEUTRONS BY DEUTERONS. J. W. Humberston (University Coll., London). Nucl. Phys., 69: 291-304(July 1965).

Kohn's variational method is used to investigate the effects on the quartet and doublet phase shifts and scattering lengths of deuteron distortion by the incident neutron in low energy neutron-deuteron scattering. The trial functions are taken to be linear in the variational parameters and the nucleon-nucleon potential is assumed to be purely central and of Yukawa shape. Two potential ranges are considered and, for each, results are obtained at four energies, including zero. From comparisons of these with no-distortion results obtained with the same two potentials it is concluded that distortion is slight in quartet states but very considerable in doublet states. The results are, however, rather insensitive to the potential range. Both quartet scattering lengths are found to be in good agreement with the experimental value of 6.2 fm, but the two doublet values of −2.03 fm and −2.35 fm, which are upper bounds, are very much less (i.e. more negative) than both possible experimental values, thus proving that these potentials are inappropriate for describing neutron-deuteron doublet scattering. (auth)

27203 NATURAL MOMENTA IN CONSTRAINED DYNAMICS. Amnon Katz (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., 69: 465-70(July 1965).

Takahashi's method of treating linear constraints in a classical system is generalized. An unsymmetrical matrix is used to project velocities and momenta. Freedom left in the choice of the matrix is used to conserve the unconstrained relation between constrained velocities and momenta. The center-of-mass problem with unequal masses is used for illustration. (auth)

27204 SOME PROPERTIES OF SU_{l+1}. M. L. Whippman (Univ. of Pennsylvania, Philadelphia). Nuovo Cimento, (10), 37: 824-30(June 1, 1965).

A procedure for labeling the states of an irreducible representation of SU_{l+1} is described, and is used to find an explicit form for the Casimir operator. The Wigner-Eckart theorem is used to derive a simple form for the matrix elements of a particular type of tensor operator. (auth)

27205 ON THE RENORMALIZATION OF THE ONE-PARTICLE ENERGIES IN A SUPERFLUID FERMI SYSTEM. N. Menyhard (Central Research Inst. for Physics, Budapest). Nuovo Cimento (10), 37: 831-41(June 1, 1965).

The fully renormalized energy gap equation is derived and expressed in terms of certain self-energy parts represented by generalized Feynman diagrams. Ladder approximation to the gap equation is given and discussed. (auth)

27206 ELECTROPRODUCTION OF MUONS OF VERY HIGH ENERGY. G. Clement and P. Kessler (College de France, Paris). Nuovo Cimento (10), 37: 876-87(June 1, 1965). (In French)

The muon beam intensities which might be obtained from existing and projected high-energy electron accelerators are evaluated. The cross section for the photoproduction of a μ (+ or −) in a forward cone of small angle, taking into account a nuclear form factor, is given. The number of muons of given energy produced by an electron is then obtained by integration over the thick target gamma spectrum. For this calculation several approximations are made which are subsequently discussed; this leads the suggestion that a few radiation lengths of a heavy element (e.g., 1 or 2 inches of lead) will give the best results. An estimate is given for the pion contamination; the ratio of pions to muons is roughly of the order of unity, provided that the angle of the production cone is taken sufficiently small (a few degrees). The results of the calculations are displayed in curves, which show the muon intensities which might be obtained from 6, 12, and 25 Bev electron accelerators; other curves show the pion contamination. (auth)

27207 THE MASS OF A NEUTRINO FROM SPINOR CONNECTION IN A RIEMANNIAN SPACE. M. Sachs (Boston Univ.). Nuovo Cimento (10), 37: 888-96(June 1, 1965).

A relation derived previously that shows a correspondence between the mass of an interacting spinor particle

and the field properties of a Riemannian space, is applied to the derivation of the ratio of neutrino and nucleon masses. The calculation is carried out in the approximation which assumes that this ratio is sufficiently small to allow the nucleon to be considered as stationary, with an associated radially symmetric Einsteinian gravitational field. The quaternion solutions of the Schwarzschild problem are thereby derived and the ratio of masses is then determined. It is found, in this approximation, to depend inversely on the square of the mutual separation between the particles. In the domain of interaction of order 10^{-14} cm, this ratio is close enough to zero to be consistent with the experimental data; it approaches unity when the radius of the interaction domain approaches the order of 10^{-32} cm. (auth)

27208 ON THE ČERENKOV RADIATION FROM A PARTICLE MOVING WITH VARYING VELOCITY. N. D. Sen Gupta (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 37: 905-17(June 1, 1965).

The electromagnetic radiation potential for a charged particle moving in an infinite homogeneous medium with varying velocity is obtained. The qualitative nature of the field and the wave front in the case of gradual retardation of the velocity is discussed. The particular case of uniform retardation is considered more elaborately. (auth)

27209 GENERALIZATION OF LEVINSON'S THEOREM FOR ALL COMPOSITE PARTICLES IN A MULTICHANNEL SCATTERING PROBLEM. R. C. Hwa (Univ. of California, Berkeley). Nuovo Cimento (10), 37: 918-23(June 1, 1965). (UCRL-11625)

On the basis of analyticity and unitarity, Levinson's theorem is generalized for a multichannel scattering problem so that bound-state poles and resonance poles are put on the same footing. The sheet structure of the Riemann surface is analyzed, and the condition for poles in the unphysical sheets is derived. The generalized formula relates the total number of composite-particle poles to the behavior of the S-matrix elements along their left-hand cuts. (auth)

27210 FIELD THEORY OF THE ELECTROMAGNETIC INTERACTIONS OF MASSIVE CHARGED VECTOR BOSONS. F. Salzman and G. Salzman (Univ. of Colorado, Boulder). Nuovo Cimento (10), 37: 924-43(June 1, 1965).

The field theory of the electromagnetic interactions of massive charged vector bosons, based on the most general second-order lagrangian, is considered. Besides the charge and mass of the spin-one quantum, the theory is characterized by three additional parameters, κ, λ, and ξ. The spin-one quantum has a magnetic dipole moment of $(1 + \kappa)$ magnetons and an electric dipole moment of λ magnetons. If $\xi > 0$, the theory also contains spin-zero quanta. The canonical formalism for the $\xi = 0$ case is carried through, and it is shown, to order e^2, that the theory can be expressed in manifestly covariant form, provided one uses a natural generalization of the definition and application of normal products in perturbation theory. If instead the calculation is performed as done by Lee and Yang, then one finds, in addition to the infinite, noncovariant, nonhermitian part of the interaction hamiltonian proportional to κ^2 that they found, a similar term proportional to e^2 alone, which however is also nongauge-invariant. The first (κ^2) of these terms contributes an infinite self-energy to the vector boson, and the second (e^2) term contributes an infinite self-energy to the photon. (auth)

27211 COUPLING CONSTANT SUM RULES FOR "SUPER" RESONANCES DECAYING INTO DECUPLET + OCTET IN BROKEN SU_3 SYMMETRY. R. Acharya (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 37: 944-52(June 1, 1965).

Under the assumption of broken SU_3, coupling-constant sum rules were derived for 8, 10, 27, and 35 going into 10 plus 8. (auth)

27212 THE ANALYTIC CONTINUATION OF AN S_{11} PION-NUCLEON AMPLITUDE TO THE P_{11} AMPLITUDE. H. Goldberg (Brandeis Univ., Waltham, Mass.) and E. L. Lomon. Nuovo Cimento (10), 37: 953-61(June 1, 1965).

The MacDowell symmetry is used to obtain the unique P_{11} pion-nucleon amplitude related to the simple analytic form of the S_{11} amplitude derived previously from a two-channel boundary condition model. The a posteriori justification for the extension of the too simple S_{11} amplitude over several Bev is the resulting satisfaction of the stringent P-state threshold requirement, and a qualitative agreement of the P-state amplitude with experimental information. (auth)

27213 BLACK BODY RADIATION FROM A SELF-CONSISTENT FIELD THEORY OF QUANTUM ELECTRODYNAMICS. M. Sachs (Boston Univ.). Nuovo Cimento (10), 37: 977-88(June 1, 1965).

An earlier derivation of a property of the nonlinear field equations of a new theory of electrodynamics, which indicates all the physical consequences of the Pauli exclusion principle for a many-particle system, is extended to a consideration of predictions that compare with the observed spectral distribution of a black-body radiation. It is shown that when a cavity is assumed to contain an arbitrary number of positronium atoms, in their ground states of null energy-momentum, the exact solutions for this state imply a dynamical uncoupling of the positronium gas from the interacting charges in the cavity walls in agreement with the experimental observations. It is further shown that when such a system of positronium atoms, treated as in ideal gas, establishes thermodynamic equilibrium, it can be described by an arbitrary number of randomly oriented distinguishable oscillators at a temperature T. The application of Maxwell-Boltzmann statistics thereby yields the Planck spectral distribution law for a system in which photons and source-free radiation play no role. (auth)

27214 MESON-BARYON MASS SPLITTINGS AND RESONANCE MULTIPLETS IN SU_3 SYMMETRY. G. Rajasekaran (Oxford Univ. and Univ. of Chicago). Nuovo Cimento (10), 37: 1004-45(June 1, 1965).

It is shown that in order that symmetry considerations be applicable to resonances occurring between the thresholds connected by the symmetry principle, the modulus of the momentum in any channel should be smaller or at least not much greater than the inverse of the range of the interaction. For the state $\Lambda^*_{\frac{5}{2}}$, simple potential models are constructed which show that this condition is satisfied thus explaining why SU_3 symmetry is approximately valid for the $p_{\frac{3}{2}}$ states $\Lambda^*_{\frac{3}{2}}$, Y^*_1, $\Xi^*_{\frac{3}{2}}$ and Ω^- in spite of the large mass splittings in the baryon and meson octet. Finally it is shown that for these $p_{\frac{3}{2}}$ states the symmetry violations in the matrix $K' = k^{-1}Kk^{-1}$ obey the group-theoretical perturbation formulae whereas the same is not true for the matrix T' defined in a similar manner from the T-matrix. (auth)

27215 SENSITIVITY OF THE VECTOR COUPLING CONSTANT TO μ-NEUTRINO MASS AND T-INVARIANCE. Alladi Ramakrishnan, K. Venkatesan, and T. S. Shankara (MATSCIENCE, Madras). Nuovo Cimento (10), 37: 1046-8 (June 1, 1965).

It is shown that the value of the vector coupling constant is sensitive to μ-neutrino mass m_{μ_ν} and for large values m_{μ_ν}, also to possible T-violation. In view of the large range of values for the coupling constant arising from these two factors, it is suggested that these quantities be determined accurately in order to consider any violation of the CVC hypothesis. (auth)

27216 NONRELATIVISTIC NUCLEON-NUCLEON POTENTIAL FROM S-MATRIX THEORY. R. Cirelli and G. M. Prosperi (Universita, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cimento (10), 37: 1049-70(June 1, 1965).

The problem of the construction of a potential capable of reproducing in the nonrelativistic region the relativistic scattering amplitude G(s,t) for two scalar nucleons is reconsidered along the lines of the method proposed by Charap and Fubini. The possibility of subtractions in s and t in the Mandelstam representation for G(s,t) is explicitly considered. If R is the number of subtractions in s, in the R = 0 case the same result is obtained as Charap and Fubini independently of the number of subtractions in t, i.e., the problem is solved by a local potential, super-

position of Yukawa potentials. In the R = 1 case a velocity-dependent potential of the form $V_0(r) - \frac{1}{2}[\Delta_2 V_1(r) + V_1(r)\Delta_2]$ turns out, instead, to be necessary. The problem of the construction of the potential is then rather complicated with respect to the R = 0 case by the necessity of subtractions in s even in the Mandelstam representation for the nonrelativistic amplitude. The problem is solved taking advantage explicitly of the Lippmann-Schwinger equation. The R = 1 case is rather interesting for various reasons: phenomenological potentials of that kind have been proposed to explain the short-range repulsion between two nucleons; it is possible to consider the exchange of vectorial mesons; it exhibits some of the typical difficulties which one encounters in the construction of a potential for two realistic spin-½ nucleons without the complications of the inherent spinor algebra. (auth)

27217 RELATIVISTIC PARTICLES IN A CONSTANT MAGNETIC FIELD. F. Strocchi (Universite de Paris, Orsay, France). Nuovo Cimento (10), 37: 1079-85(June 1, 1965).

The relativistic limit of particles with arbitrary spin in a constant magnetic field is obtained by performing a unitary transformation on the Bargmann-Wigner equations. The new representation proves particularly convenient in studying the behavior of an electron with anomalous magnetic moment in a constant magnetic field. The energy eigenvalues may be easily found. Moreover in the high-energy limit ($m \ll \omega$) the depolarization is shown not to depend on kinematical factors in contrast with the medium-energy case studied by Mendlowitz and Case. (auth)

27218 ZERO-MASS AND NONDECOMPOSABLE REPRESENTATIONS. R. Shaw (Hull Univ., Eng.). Nuovo Cimento (10), 37: 1086-99(June 1, 1965).

The zero-mass representation $\varphi'(p) = \exp[ip \cdot a]Q(\Lambda)\varphi(\Lambda^{-1}p)$ of the inhomogeneous Lorentz group is considered, in the case when $\Lambda \to Q(\Lambda)$ is the representation $\mathcal{D}(s, 0)$ of the homogeneous group, and found to be reducible but not decomposable. Nevertheless it is shown how to extract from it unitary irreducible representations corresponding to helicities s, s − 1, ..., −s. (auth)

27219 SHRINKAGE OF THE DIFFRACTION PEAK IN HIGH-ENERGY ELASTIC SCATTERING. C. Iso (Tokyo Inst. of Tech.). Nuovo Cimento (10), 37: 1100-11(June 1, 1965).

An attempt is made to study whether it is necessary to consider the correlations between the secondaries of multiple particle production as Van Hove suggests in order to explain the shrinkage of the angular distribution of p-p elastic-scattering cross section in the energy region between 5 and 30 Bev. Two possibilities to explain the shrinkage are considered: the real part of the amplitude of the elastic scattering has a slower dependence on t than the imaginary part and decreases with increasing energy, or even if one assumes (Van Hove's) no correlations between the secondaries, the logarithm of the imaginary part of the scattering amplitude has energy-dependence. It is shown that the first possibility contradicts with theory and the second one is acceptable. (auth)

27220 LOW-ENERGY Λ-NUCLEON SCATTERING BY N/D METHOD. S. M. Vaidya, S. N. Biswas, and V. Gupta (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 37: 1112-18(June 1, 1965).

The singlet and triplet scattering lengths of the Λ-N system in s-state were determined by the dispersion-theoretical approach of the S-matrix. A variant of the N/D method of the solution of the dispersion relations as proposed and utilized by Balàzs was adopted. The results are compatible with the phenomenological findings of Dalitz and Downs. The singlet phase shift is in reasonable agreement while the triplet phase shift comes out too large. (auth)

27221 RELATION BETWEEN THE COUPLING CONSTANT AND THE SINGULARITY IN THE SECOND SHEET. T. Sawada (Univ. of Colorado, Boulder). Nuovo Cimento (10), 37: 1126-42(June 1, 1965).

A method is given to derive a relation between masses and coupling constants from the unitarity condition and its analytic continuation, and the assumption that every pole or pole-like singularity on the first or the second sheet has a definite angular momentum in some channel (s, t, or u). This technique is applied to calculate the pion-baryon coupling constant using the baryon-baryon scattering amplitudes. There are two solutions: $f^2 \equiv (g^2/4\pi)(\mu/2m)^2 = \mu/2m$, and $f^2 = 0$. The results are exact within the framework of strong interactions. The consistency of factorizability is checked, and the discrepancy of this turns out to be less than two per cent. (auth)

27222 PION-NUCLEON COUPLING CONSTANT FROM n-p DIFFERENTIAL CROSS-SECTIONS OVER AN ENERGY RANGE. R. Cirelli (Universita, Milan and Istituto Nazionale di Fisica Nucleare, Milan) and G. Stabilini. Nuovo Cimento (10), 37: 1165-9(June 1, 1965).

The pion-nucleon coupling constant is determined by extrapolation to the backward one-pion-exchange pole over a large energy range. Data on the neutron-proton differential cross section ranging from 62.5 to 550 Mev are used in the treatment. The values of g^2 obtained by this global determination turn out to be rather good. (auth)

27223 PRODUCTION AMPLITUDES. I. CONSTRUCTION OF INVARIANT AMPLITUDES. A. O. Barut and Y. C. Leung (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 138: B1119-27(June 7, 1965).

Lorentz-covariant scattering amplitudes for production processes involving both massive and massless particles are systematically discussed. Explicit forms of both the spin and the isospin amplitudes for production processes involving pions, nucleons, photons, and neutrinos, as well as the crossing relations in both spin and isospin variables, are given. (auth)

27224 PRODUCTION AMPLITUDES. II. PARTIAL-WAVE DECOMPOSITION AND ANALYTIC CONTINUATION IN TOTAL ANGULAR MOMENTUM. A. O. Barut and Y. C. Leung (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 138: B1128-35(June 7, 1965).

The problem of analytic continuation in total angular momentum j of a production amplitude is investigated on the basis of analyticity in one of the momentum-transfer variables z for definite combinations of helicity amplitudes which are free of certain kinematical singularities. On this basis also an upper bound for production amplitudes is obtained which has the same value for all z as the bound of a forward-scattering elastic-scattering amplitude. Furthermore, the consistency of the analyticity in the whole cut z plane is investigated. For this case the singularities in the j plane extend indefinitely to the right even if only N subtractions are made. These singularities are removed only if the spectral functions satisfy certain integral relations to the effect that they oscillate more rapidly for higher spin. When these conditions are satisfied the essential singularities of the Gribov-Pomeranchuk type need not be introduced. The analysis further shows the dynamical role played by the spin variable in an analytic S-matrix theory. (auth)

27225 LOW-ENERGY π-Λ INTERACTION, AND THE ΣΛπ COUPLING CONSTANT. B. R. Martin (Universitet, Copenhagen). Phys. Rev., 138: B1136-47(June 7, 1965).

A semiphenomenological study of the dynamics of the first hyperon resonance Y_1^* (1385) was made in a one-channel approximation by the techniques of partial-wave dispersion relations. Contributions from Σ and Y_1^* exchange, and the exchange of a low-energy s-wave π-π pair, to dispersion relations for the P_3 π-Λ scattering amplitude were evaluated on the physical and crossed physical cuts. The coupling constant $g_{\Sigma\Lambda\pi}$ and a parameter related to the P_3 π-Λ scattering length were varied so that the amplitude calculated from the dispersion relation was consistent with the input resonant amplitude on both cuts simultaneously. This could be achieved for $g^2_{\Sigma\Lambda\pi} = 10.9 \pm 0.3$. The dynamics of Y_1^* are found to depend almost as much on the exchange of the s-wave π-π pair as on Σ exchange. (auth)

27226 STUDY OF THE ABSORPTION MODEL IN PION-NUCLEON CHARGE-EXCHANGE SCATTERING. V. Barger and M. Ebel (Univ. of Wisconsin, Madison). Phys. Rev., 138: B1148-54(June 7, 1965). (COO-30-98)

The predictions of a peripheral ρ-exchange model with absorption are studied for the π^-p charge-exchange reaction. Comparisons with experiment of predicted differential cross sections are made at laboratory momenta of 5.9 and 10.0 Bev/c. It is found that absorption parameters determined from pion-nucleon elastic-scattering data fail to provide a fit to the angular distribution, absolute magnitude, or energy dependence of the observed cross sections. Even the assumption of essentially complete absorption of low partial waves still fails to fit absolute magnitudes and energy dependence, but it can give an acceptable angular dependence if the anomalous magnetic coupling of the ρ is neglected. It is concluded that the simple absorption model is not an adequate representation of the experimental situation. Implications and possible modifications of the theory are discussed. (auth)

27227 HIGH-ENERGY ELASTIC SCATTERING AT LOW MOMENTUM TRANSFERS. Thomas O. Binford (Univ. of Wisconsin, Madison) and Bipin R. Desai. Phys. Rev., 138: B1167-73(June 7, 1965).

The $K^\pm p$, $\pi^\pm p$, pp, and $\bar{p}p$ data in the laboratory-energy region between 7 and 20 Bev and momentum transfer squared, $-t$, less than 0.5 $(Bev/c)^2$ are analyzed in terms of the P,P', and ω Regge poles. A linear approximation to the trajectories is made with slopes α' assumed to be equal. The reduced residues of P and P' are taken to be of the form $(1-b_i t)^{-\epsilon_i}$, $i = P, P'(b_i > 0)$. In order to explain the difference between the antiparticle (K^-p and $\bar{p}p$) and particle (K^+p and pp) differential cross sections, the ω residue should have a zero at a negative value of t. Hence, the reduced residue for ω is taken to be of the form $(1 + t/t_0)(1-b_\omega t)^{-\epsilon_\omega}$, where t_0 is the position of the zero. The values $\epsilon_P = \epsilon_{P'} = 2.5$ and $\epsilon_\omega = 3.5$ are chosen in order to conform to the high-momentum-transfer behavior $(d\sigma/dt \sim t^{-5})$ observed in pp scattering. The t = 0 values of the residues and the trajectory intercepts are known from other considerations. Covering the above range of energy and momentum transfer, one has five parameters for each of the antiparticle-particle sets, $K^\pm p$ and $pp-\bar{p}p$, and three parameters for $\pi^\pm p$, of which α' and (from factorization) the t_0's should be the same between the different sets. The α' values turn out to be the same (= 0.41 $(Bev/c)^{-2}$) for each set, while the t_0 values are reasonably close: 0.061 $(Bev/c)^2$ for $K^\pm p$ and 0.074 $(Bev/c)^2$ for $\bar{p}p-pp$. It is found that the residues of P contribute substantially to the diffraction widths. A crude estimate of the contribution of branch cuts indicates that they will not be important compared to P in the above region of energy and momentum transfer. (auth)

27228 RESIDUES OF REGGE POLES AND THE DIFFRACTION PEAK. Bipin R. Desai (Univ. of California, Los Angeles). Phys. Rev., 138: B1174-82(June 7, 1965).

It is shown, on the basis of potential theory, that for a Regge pole with position $\alpha(t) > \frac{1}{2}$ the reduced residue $\beta(t)/\nu^{\alpha(t)}$ behaves essentially as $[\alpha'(t)/R]R^{2\alpha(t)}$ near threshold ($\nu \lesssim 0$), where R is the effective radius interaction. The quantity $\gamma(t) = (m_\pi^2/\nu)^\alpha \beta(t)$ which occurs in the asymptotic term $\gamma(t)\,(s/2m_\pi^2)^\alpha$ can therefore be considered as a slowly varying function of t only if one takes $m_0 = R^{-1}$. Assuming that the threshold expression gives a qualitative description in the relativistic case, it is noted that if MR > 1, where M is the nucleon mass, then the normalization $m_0 = M$ used in high-energy phenomenology will give rise to an exponential falloff of $\gamma(t)$ with $(\text{width})^{-1} \approx 2\alpha'(0)\ln(MR)$. The values of R in the t channel of $\pi\pi$, πN, and NN, estimated from the knowledge of the nearest left-hand branch points or factorization, occur in increasing order, and for each of them MR > 1. The results for the Pomeranchuk trajectory roughly reproduce the exponential diffraction shape and indicate that a larger total cross section implies a sharper falloff of the amplitude in the diffraction region. A connection between f^0 and the diffraction width is discussed, as well as the question of zeros in β/ν^α. (auth)

27229 NORMALIZATION CONDITION AND NORMAL AND ABNORMAL SOLUTIONS OF THE BETHE-SALPETER EQUATION. Noboru Nakanishi (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 138: B1182-92(June 7, 1965). (BNL-8786)

The normalization constants for normal and abnormal solutions of the Bethe-Salpeter equation are explicitly calculated in the Wick-Cutkosky model. In the case of the vanishing total four-momentum, it is shown that the abnormal solutions with odd κ have a negative norm, where κ is the Wick-Cutkosky quantum number, and that the corresponding scattering Green's function contains all the normal and abnormal solutions as the residues of poles. It is demonstrated explicitly for $\kappa = 0, 1, 2, 3$ that the first conclusion remains true also in the case of an infinitesimally positive mass. As for the case of massless bound states, its special character is emphasized, and solid harmonics are constructed corresponding to the little group for a massless particle. Non-Cutkosky integral equations are obtained for the weight functions of the integral representation for the Bethe-Salpeter amplitude. (auth)

27230 DECAY OF DECUPLET BARYON RESONANCES AND THE SU(6) SYMMETRY. V. de Alfaro and Y. Tomozawa (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 138: B1193-4(June 7, 1965)

The SU(6) symmetry is applied to derive the sum rules between the decay amplitudes of decuplet baryon resonances, in the presence of symmetry-breaking interactions. Two relations are obtained. The first is the same relation as in the complete SU(3) symmetry and is known to be well satisfied experimentally. Experimental fit of the second shows 1.4 standard deviations, while that of the corresponding relation of complete SU(3) symmetry shows 5 standard deviations. (auth)

27231 SENSE-NONSENSE CHANNELS IN AN APPROXIMATE N/D MODEL. Y. N. Srivastava and P. Nath (Univ. of California, Riverside). Phys. Rev., 138: B1195-6(June 7, 1965).

The decoupling of sense-nonsense Regge amplitudes at a physical angular momentum when external particles have spin is investigated. As discussed by Abers and Zachariasen, various approximation schemes to the N/D matrix equations that are available do not seem to decouple the sense and nonsense channels in an appropriate manner. It is shown, through the specific example of vector-scalar scattering, that an approximate amplitude suggested earlier seems to decouple properly. The amplitude, being unitary and symmetric (time-reversal invariant), and having the same degree of simplicity as (for example) the determinantal approximation, may be of use in rudimentary spinological bootstraps. (auth)

27232 DOUBLE POLES AND NONEXPONENTIAL DECAYS. J. S. Bell (Stanford Univ., Calif.) and C. J. Goebel. Phys. Rev., 138: B1198-1201(June 7, 1965). (SLAC-PUB-62)

Models are constructed with double poles in partial-wave scattering amplitudes. The associated unstable particles have nonexponential decay laws which contain parameters dependent on the production and detection arrangements. (auth)

27233 INTERNAL SYMMETRIES IN BOOTSTRAP DISPERSION RELATIONS. Jerrold Franklin (Univ. of California, Livermore). Phys. Rev., 138: B1202-7(June 7, 1965). (UCRL-12316)

A procedure is given for determining conservation laws for strong interactions that satisfy crossing-symmetric dispersion relations. Given a particular degeneracy structure, the procedure determines the most general conservation law consistent with the degeneracy structure and which is a likely outcome of a bootstrap calculation. The method does not involve detailed dynamical calculations, nor is it dependent upon any approximations. It is shown that it is sufficient to study the structure of the pole terms to derive the conservation law. The procedure is applied to the strong interactions of pions and nucleons and then to the pseudoscalar meson and baryon octets; one arrives at charge independence in each case. (auth)

27234 POSSIBLE METHOD FOR ISOLATING THE K*-EXCHANGE CONTRIBUTION TO THE REACTION $\gamma + p \rightarrow K^+ + \Lambda$. [PART] II. S. Barshay (State Univ., New Brunswick, N. J.) and M. Kawaguchi. Phys. Rev., 138: B1219-21 (June 7, 1965).

The possibility of obtaining good estimates of the vector and tensor coupling parameters associated with the $K^*\Lambda N$ vertex from measurements on the reaction $\gamma + p \rightarrow K^+ + \Lambda$ with both unpolarized and linearly polarized photons at moderate energies was previously indicated. The numerical results from the formulas which suggest feasible experiments to distinguish various combinations of the coupling parameters are given. (auth)

27235 ANALYTIC PROPERTY OF THREE-BODY UNITARITY INTEGRAL. Jamal N. Islam and Y. S. Kim (Univ. of Maryland, College Park). Phys. Rev., 138: B1222-9(June 7, 1965).

Analytic properties of the three-body unitarity integral are studied for the production amplitude corresponding to one-particle-exchange diagrams. The condition under which the absorptive part has singularities is discussed. For a simple degenerate case, it is shown that the singularity curve can be represented by an explicit elementary function. It is shown further that this singularity curve is identical to that from the conventional Landau-Bjorken analysis. (auth)

27236 SINGLE π^- PRODUCTION IN n-p COLLISIONS NEAR THRESHOLD. Robert Handler (Univ. of Chicago). Phys. Rev., 138: B1230-44(June 7, 1965).

Over 4000 $n + p \rightarrow \pi^- + p + p$ events, obtained in a hydrogen bubble chamber, were analyzed. The kinetic energies of the initiating neutrons ranged from threshold to 440 Mev. The angular distributions, correlations, and energy partition of the final-state particles as well as the excitation function are presented. They are in excellent agreement with the phenomenological theory of Gell-Mann and Watson, except for the absence in the data of a sharp peak in the momentum partition distribution near the maximum allowed π^- momentum. The Ps amplitudes account for less than 1% of the total cross section. The intensities of the various types of transitions are determined. Examples of sets of amplitudes which yield these intensities are given. However, a large number of amplitudes contribute to the cross section, and the ambiguities are too great to allow evaluation of individual amplitudes. (auth)

27237 DYNAMICAL MODEL OF THE Σ. Boris Kayser (California Inst. of Tech., Pasadena). Phys. Rev., 138: B1244-59(June 7, 1965). (CALT-68-5)

In the spirit of the bootstrap hypothesis, a dynamical model is developed for the Σ hyperon, taking into account the $\pi\Lambda$ and $\pi\Sigma$ channels. Born amplitudes for the exchange of Λ, Σ, Y_1^* (1385 Mev), Y_0^* (1405 Mev), and ρ form the inputs to dynamical calculations that are based on the matrix ND^{-1} method and are intended partly as a practical study of this technique. It is shown that the ND^{-1} formalism can be trivially extended to handle the situation where an input force cut overlaps the unitarity cut below physical threshold. In the dynamical calculations, the properties of all particles other than the Σ are taken from experiment, or, where they are experimentally uncertain, estimated on the basis of current theoretical ideas and then varied. The cutoff which governs the damping of the input amplitudes at high energies is also varied. It is found that quite a few combinations of the experimental unknowns and the cutoff do lead to a self-consistent $\frac{1}{2}^+$, I = 1, $\pi\Lambda$-$\pi\Sigma$ bound state, identified as the Σ, with reasonable values for the mass M_Σ and couplings $g_{\pi\Lambda\Sigma}^2/4\pi$ and $g_{\pi\Sigma\Sigma}^2/4\pi$. These results favor the conjecture that the Σ is a composite particle. (auth)

27238 INELASTIC UNITARITY CONTRIBUTIONS TO $S_{\frac{1}{2}}$, T = $\frac{1}{2}$ PION-NUCLEON SCATTERING LENGTH. S. N. Biswas (Univ. of Delhi), H. Banerjee, and R. P. Saxena. Phys. Rev., 138: B1260-1(June 7, 1965).

Inelastic unitarity contribution to the pion-nucleon $S_{\frac{1}{2}}$, T = $\frac{1}{2}$ zero-energy scattering length was determined following the modified N/D formalism due to Froissart. The fixed-energy dispersion relations and the experimental information for the s-wave inelastic parameter were used to solve the resulting dispersion equations in the effective-range approximation method of Balázs. A large positive scattering length is found, indicating that the inclusion of inelastic effects generates an attractive interaction in the s wave. (auth)

27239 TROUBLE WITH RELATIVISTIC SU(6). Sidney Coleman (Harvard Univ., Cambridge, Mass.). Phys. Rev., 138: B1262-7(June 7, 1965).

Recently, a relativistic generalization of the SU(6) group, based on $U(6) \otimes U(6)$ has been proposed. The smallest group containing this group and the Poincaré group is found. This group has the catastrophic feature that all of its faithful unitary representations contain an infinite number of states for fixed four-momentum; thus there are an infinite number of particles in every supermultiplet. It is conjectured that similar difficulties afflict every group that contains an internal symmetry group and the Poincaré group in such a way that these groups do not commute. The conjecture is proven for a large class of Lie groups (semidirect products of semisimple groups and Abelian groups) under a restrictive assumption (that the translations are contained in the Abelian group). (auth)

27240 PHOTOPRODUCTION OF MUON PAIRS. Allen S. Krass (Univ. of California, Santa Barbara). Phys. Rev., 138: B1268-73(June 7, 1965).

The virtual Compton corrections to muon pair production are analyzed and compared with the Bethe-Heitler cross section for symmetric pairs. The three corrections studied are the peripheral, diffraction, and "compound state" processes. It is shown that the peripheral processes will be the first to give significant corrections as the photon energy and muon detection angle are increased in future experiments. It is predicted that μ-pair experiments should be interpretable as pure Bethe-Heitler processes (and therefore valid tests of quantum electrodynamics) up to photon energies of 10 Bev and muon angles of 18° in the lab system (auth)

27241 SINGLE-CHANNEL CALCULATION OF THE ρ RESONANCE WITH INELASTIC UNITARITY. Philip W. Coulter and Gordon L. Shaw (Stanford Univ., Calif.). Phys. Rev., 138: B1273-8(June 7, 1965).

The width and shape of the ρ resonance are computed from a single-channel N/D formalism with inelastic unitarity. The input force is assumed to be furnished primarily by the exchange of the ρ in the crossed channels. The input mass (760 Mev) and width (~100 Mev) are taken from experiment. The inelastic factor η is assumed to be determined by the $\pi\pi \rightarrow \pi\omega$ reaction at low energy and fitted to various arbitrary forms at higher energies. A cutoff is adjusted to produce the ρ resonance at the observed energy. The smallest output width obtained is 250 Mev, as compared with 600 Mev for the pure-elastic-scattering ($\eta \equiv 1$) calculation. A more nearly symmetric shape for the resonance is obtained when inelastic effects are considered. (auth)

27242 PHASE REPRESENTATION AND HIGH-ENERGY BEHAVIOR OF THE FORWARD SCATTERING AMPLITUDE. Y. S. Jin and S. W. MacDowell (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 138: B1279-85(June 7, 1965).

By making use of the phase representation, the relation between the high-energy behavior of the symmetric forward scattering amplitude F(x) and the asymptotic properties of the ratio $\cot\delta = \mathrm{Re}F/\mathrm{Im}\,F$ is discussed. Starting assumptions are dispersion relations and the Greenberg-Low bound. Lower bounds as well as upper bounds are derived. Under the assumption of the Froissart bound, it is shown that $\cot\delta$ cannot stay indefinitely greater than an arbitrarily small positive number. Also if the total cross section decreases steadily to a finite limit, but slower than const/E, the real part must tend to $-\infty$. The results are discussed in connection with those of Khuri and Kinoshita. The unsymmetric case is also treated by the same methods. (auth)

27243 MODIFIED ISOBAR APPROXIMATION FOR π-ρ SCATTERING. Wayne J. Holman, III (Army Electronics Labs., Fort Monmouth, N. J.). Phys. Rev., 138: B1286-1303(June 7, 1965).

The equations for the scattering amplitude for three pions in a $J = 1^-, T = 0$ state, subject to the approximation of elastic unitarity, are formulated in accordance with the N/D method. It is assumed that the incoming and outgoing pions resonate in pairs. A new method of approximation is introduced for the integration over the invariant mass of the intermediate resonance in the unitarity condition: Phase-volume factors as well as the resonance denominators are used to define the mass of the intermediate resonance, which then becomes a function of the total channel energy. Upon writing the coupled integral equations for the N/D representation of the amplitude, using as input functions for N the proximate singularities of the π, ω, and ρ exchange graphs, it is found that the branch points for these singularities are functions of the total channel energy. That is, the unphysical singularities become movable. When an attempt is made to evaluate D numerically and locate the ω resonance as a zero of its real part, determined by the requirement of the consistency of M_ω and Γ_ω with the values used in the input function, it is found that the repulsive pion-exchange term dominates the integral, and hence it is not possible to obtain a self-consistent ω resonance. The recoupling terms are considered only qualitatively, and methods of approximation are suggested for them. The physical consequences of the movable cuts are discussed in detail. (auth)

27244 DETERMINATION OF THE PROTON'S ELECTRIC AND MAGNETIC SPECTRAL FUNCTIONS. Bryan A. Orman (Univ. of Alberta, Edmonton). Phys. Rev., 138: B1308-12(June 7, 1965).

The solution of the well-known airfoil equation is used to determine the spectral functions of the proton. The constraint that the electric and magnetic form factors are equal at threshold for proton-antiproton annihilation into an electron-positron pair is used throughout. A comparison of the results is made with the preliminary measurements of the cross section for this process and the Sachs constraint at infinite momentum transfer is also examined. Spectral functions with a peak around 780 Mev, a zero around 1150 Mev, and a broad minimum around 1400 Mev are found. (auth)

27245 PHOTOPRODUCTION OF NEUTRAL K MESONS. S. D. Drell and M. Jacob (Stanford Univ., Calif.). Phys. Rev., 138: B1312-17(June 7, 1965). (SLAC-PUB-65)

Photoproduction of a neutral K-meson beam at high energies from hydrogen is computed in terms of a K^* vector-meson exchange mechanism corrected for final-state interactions. The results are very encouraging for the intensity of high-energy K_2 beams at high-energy electron accelerators. A typical magnitude is 20 μb/sr for a lower limit of the K^0 photoproduction differential cross section, at a laboratory peak angle of 2°, for 15-Bev incident photons. (auth)

27246 ABSORPTION EFFECTS IN REACTION $K^+ + n \rightarrow K^{*0} + p$ AT 2.3 Bev/c. D. L. Lin (State Univ. of New York, Buffalo). Phys. Rev., 138: B1318-19(June 7, 1965).

Using the distorted-wave Born approximation to take into account the absorption effects due to the competing open channels in the initial and final states of KN elastic scattering, the differential cross section for the reaction $K^+ + n \rightarrow K^{*0} + p$ at 2.3 Bev/c is calculated assuming one-pion exchange. The remarkable agreement of the result with a recent measurement suggests that the Kp production of K^* with charge exchange may be understood through one-pion exchange. The contribution of one-pion exchange to the production of charged K^* is briefly discussed. (auth)

27247 COLLECTIVE MOTION IN FINITE MANY-PARTICLE SYSTEMS. [PART] II. Abraham Klein (Univ. of Pennsylvania, Philadelphia) and Arthur K. Kerman. Phys. Rev., 138: B1323-32(June 7, 1965).

An attempt is made to exploit a generalized self-consistent approach to the study of collective excited states in finite many-particle systems. A restatement of the equations of the method with further discussion of the basic approximations involved, and a study, through the medium of the exactly soluble problem of uniform translational motion, of the inherent limitations in accuracy of the method when applied to the "strong-coupling" limit for which it was designed are contained. A mode of approximation which can be made self-consistent is indicated. This approximation is applied to the problem of rotational motion in a plane. In the further limit in which one assumes the spectrum of the rigid rotator, one regains the results of the self-consistent cranking model. In contrast to previous work, the possibility of removing this limitation is indicated, but remains to be carried through. (auth)

27248 EIGENVALUES OF FERMION DENSITY MATRICES. Fukashi Sasaki (Uppsala Univ.). Phys. Rev., 138: B1338-42(June 7, 1965).

The least upper bound of the eigenvalues of second-order reduced density matrices for a system of fermions is proved to be n for a system of 2n or 2n + 1 identical fermions. It is also shown that this limiting state may be interpreted as a system of identical pairs behaving as quasibosons. (auth)

27249 MINIMUM PRINCIPLE FOR EFFECTIVE POTENTIALS. Leonard Rosenberg (New York Univ., New York). Phys. Rev., 138: B1343-?(June 7, 1965).

In the familiar Rayleigh-Ritz method, a finite-dimensional hamiltonian matrix is constructed using a set of linearly independent trial functions. The eigenvalues of this matrix, suitably ordered, are guaranteed to lie above the corresponding true eigenvalues. An analogous situation is shown to hold in scattering theory for energies low enough so that only two-body channels are open. An effective hamiltonian, which is a matrix in the open-channel subspace, is constructed variationally. Since the corresponding Schrödinger equation is of the two-body type, it may be solved, numerically if necessary. The eigenvalues of the reaction matrix, in a partial-wave representation, are then guaranteed to lie below the true eigenvalues. The essential point involved is that the error in the effective hamiltonian can be shown to be a nonpositive operator, provided the trial function satisfies a certain natural constraint. Effects due to the identity of particles are easily accounted for. As an application, the three-body problem is considered in some detail, and the required constraint on the trial function is explicitly defined for this problem in terms of simple orthogonality conditions. (auth)

27250 LOW-ENERGY ELASTIC K^+-d SCATTERING WITH SEPARABLE POTENTIALS. J. H. Hetherington and L. H. Schick (Univ. of Minnesota, Minneapolis). Phys. Rev., 138: B1411-20(June 21, 1965). (COO-1371-11)

Low-energy K^+-d elastic-scattering cross sections are calculated using a Fadeev type of multiple-scattering formalism. The two-body interactions are taken to be S-wave nonlocal separable potentials of the Yamaguchi form. Coulomb forces, and the K^+-K^0 and n-p mass differences are neglected. The elastic angular distribution and cross section, as well as the total cross section, are calculated for incident kaon laboratory momenta in the range 110–230 Mev/c. In this momentum range it is found that for the elastic scattering cross sections the impulse-approximation result is within 10–25% and the double-scattering-approximation result is within 10% of the correct value. It is also found that in order for the optical theorem to give a good result for the total cross section, triple-scattering terms must be included. A detailed examination of the multiple-scattering series is made in order to illuminate these results. (auth)

27251 CALCULATION OF THE K^* VECTOR MESON PARAMETERS FROM ONE- AND TWO-PARTICLE EXCHANGE FORCES. J. L. Gervais (Centre de Physique de l'Ecole Polytechnique, Paris and Faculte des Sciences, Orsay, France). Phys. Rev., 138: B1457-69(June 21, 1965).

Previous calculations of the K* parameters by Diu, Gervais, and Rubinstein, based on the approximation of Zachariasen and Zemach, are improved by taking into account two-particle exchange forces using a method already proposed for the ρ bootstrap. The forces due to $K\pi$ and $\pi\pi$ exchange are added to the ρ and K* forces considered by Diu, Gervais, and Rubinstein. Self-consistent solutions are obtained both in the one-channel problem ($K\pi$ scattering with elastic unitarity) and in a two-channel problem involving the $K\pi$ and $K\eta$ states. In contrast to the one-particle exchange forces, the forces obtained are really strong enough to generate the K*. Consequently, the numerical results show a much better agreement with experiment. Assuming that Sakurai's universality holds for the ρ coupling, a one-parameter family of solutions is obtained. The coupling constants ($K^*K\pi$), ($K^*K\eta$), and ($\rho\pi\pi$) are calculated for several values of $m_{K^{*2}}$. The first two have the right order of magnitude while the third one comes out in agreement with experiment. The qualitative features of the one-particle exchange model are shown to be maintained when two-particle exchange forces are added. This raises the possibility that they are not linked to the approximation of the forces. Thus one might understand why they are in agreement with experiment even though the one-particle exchange forces do not really give a good approximation of the unphysical jumps considered in the problem. (auth)

27252 VECTOR MESONS AND REGGE TRAJECTORIES. K. Ahmed (Imperial Coll. of Science and Tech., London). Phys. Rev., 138: B1470-3(June 21, 1965).

Freund and Oehme's note concerning Reggeization of massive vector mesons in field theory is re-examined in the light of Polkinghorne's work; it is found that the Regge-pole approximation for the vector meson is not entirely justified. (auth)

27253 UNITARY SYMMETRY VIEWED AS A BROKEN ROTATIONAL INVARIANCE. Y. Ne'eman (California Inst. of Tech., Pasadena) and I. Ozsvath. Phys. Rev., 138: B1474-87(June 21, 1965).

The incorporation of $\Delta Q = -\Delta S$ currents into SU(3) theory implies its extension into an R(8) symmetry. Universality requires that these skew currents have a much weaker coupling than the $\Delta S = -\Delta Q$ transitions. The R(8) currents may cause the breakdown of CP invariance as suggested by Wolfenstein. An R(8) model would not allow the existence of SU(3) triplets. (auth)

27254 NONLEPTONIC DECAYS OF K_1^0 AND HYPERONS WITH $K^* \rightarrow \pi$ WEAK VERTEX. W. W. Wada (Ohio State Univ., Columbus). Phys. Rev., 138: B1488-9(June 21, 1965).

A unified picture is obtained for the nonleptonic decays of the K_1^0 and the hyperons in the s-wave channel by assuming the dominance of the $K^* \rightarrow \pi$ weak vertex. The universality in the coupling strength of the K* to all strangeness-changing F-type vector currents appears to be maintained. (auth)

27255 ANALYSIS OF CP-NONINVARIANT INTERACTIONS AND THE K_1^0, K_2^0 SYSTEM. T. D. Lee (Columbia Univ., New York) and L. Wolfenstein. Phys. Rev., 138: B1490-6(June 21, 1965). (TID-21819)

In order to explain the recent observation of $K_2^0 \rightarrow \pi^+ + \pi^-$ by Christenson et al., it is assumed that the relevant interaction hamiltonian can be separated into two parts: $H_C + H_F$, where H_C is the usual CP-conserving the T-invariant weak interaction and H_F is a new interaction which is not invariant under CP. Depending on the selection rule of H_F with respect to the strangeness quantum number S, this new interaction H_F can be much stronger than H_C, or somewhat weaker than H_C, or very much weaker than H_C. The properties of these three different classes of possibilities are discussed and some possible experimental tests are suggested. The system of K_1^0 and K_2^0 is analyzed for these different possibilities without assuming the validity of CPT invariance. Efforts are made to separate out the various experimental consequences that follow from different symmetry requirements which may be satisfied by this new CP-noninvariant interaction H_F. (auth)

27256 MASS DIFFERENCE OF Ξ^- AND Ξ^0. Tetsuo Sawada and Asim O. Barut (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 138: B1497-1500 (June 21, 1965).

As an application of the method for computing coupling constants, the $\Xi^- - \Xi^0$ mass difference is calculated from the consistency requirement on the various determinations of the same coupling constant. Predictions concerning $NN\pi$ and $\Sigma\Sigma\pi$ couplings are also made. (auth)

27257 PION THEORY OF RELATIVISTIC NUCLEON-NUCLEON INTERACTION. Suraj N. Gupta, Richard D. Haracz, and James Kaskas (Wayne State Univ., Detroit). Phys. Rev., 138: B1500-6(June 21, 1965).

The one- and two-pion-exchange contributions to the nucleon-nucleon interaction, which seem to predominate outside the phenomenological core, are investigated in the exact relativistic form up to fourth order in the pion-nucleon coupling constant. It is shown that the fourth order radiative correction to the usual one-pion-exchange interaction is not negligible for larger scattering angles and higher energies. Further, the fourth-order two-pion-exchange interaction is found to contain appreciable relativistic effects, and in particular the relativistic spin-orbit interaction is found to be larger than the nonrelativistic estimates. These results can be expected to yield a more precise determination of the role of the one- and two-pion-exchange interactions in nucleon-nucleon scattering. (auth)

27258 FURTHER ANALYSIS OF FORM FACTORS IN K_{l3}^+ DECAY. Gary L. Jensen, C. Thornton Murphy, and Byron P. Roe (Univ. of Michigan, Ann Arbor). Phys. Rev., 138: B1507-8(June 21, 1965).

The data from the experimental study of the $K_{\mu 3}^+$ and K_{e3}^+ decay modes in the 12-in. xenon bubble chamber were reanalyzed without the assumption of the time-reversal invariance. If a local, V−A interaction is assumed, the matrix element for the K_{l3}^+ decay is characterized by two form factors, f_+ and f_-. The ratio of these form factors $\xi = f_-/f_+$ must be real if the interaction is invariant under time reversal. The experimental distribution in two variables (p_π and p_μ) was fitted to the theoretical distribution with the real and imaginary parts of ξ as parameters. It is found that the imaginary part of ξ is consistent with zero and is less than 2.4 with 90% confidence. A further test of nonlocality is also presented. (auth)

27259 ANGULAR DISTRIBUTION OF CHARGE EXCHANGE AND INELASTIC NEUTRONS IN π^--p INTERACTIONS AT 31.3 AND 371 Mev. Don L. Lind, Barry C. Barish, Richard J. Kurz, Philip M. Ogden, and Victor Perez-Mendez (Univ. of California, Berkeley). Phys. Rev., 138: B1509-17(June 21, 1965). (UCRL-11435(Rev.))

Neutron angular distributions from the charge-exchange (π^0n) and inelastic modes ($\pi^0\pi^0$n, $\pi^+\pi^-$n) of the π^--p interaction were investigated at 313 and 371 Mev incident-pion kinetic energy. The data were obtained with an electronic counter system. Elastic and inelastic neutrons were separated in the all-neutral final states by time of flight. At both energies the charge-exchange differential cross section at the forward neutron angles differ from that determined by Caris et al. from measurements of the π^0-decay gamma distributions, but generally agrees with the phase-shift-analysis calculations of Roper. The distribution of inelastic neutrons from both modes shows a strong preference for low center-of-mass neutron energies. The distribution of these neutrons does not correspond to that expected from the I = 0, π-π interaction (ABC effect) suggested to account for the anomaly in p-d collisions observed by Abashian et al. Finally, all available charge-exchange differential-cross-section data from this and other experiments were combined by a least-squares fit to a Legendre expansion. (auth)

27260 PARAMETRIC EXPRESSION FOR p-p OFF-ENERGY-SHELL MATRIX ELEMENTS AND p-p BREMS-

STRAHLUNG. M. I. Sobel (Northeastern Univ., Boston). Phys. Rev., 138: B1517-24(June 21, 1965).

An equation is derived which expresses the off-energy-shell matrix elements of the p-p interaction in a form analogous to the phase-shift expansion for elastic scattering. Quasi phase parameters which play the role of phase shifts in this expression are calculated from phenomenological potentials. The p-p bremsstrahlung, with gamma rays observed perpendicular to the scattering plane of the incident proton, is discussed as a process which may permit experimental study of these parameters. (auth)

27261 ASYMPTOTIC PROPERTIES OF THE S MATRIX FOR SINGULAR POTENTIALS. R. J. Jabbur (Columbia Univ., New York). Phys. Rev., 138: B1525-7(June 21, 1965).

Two theorems on scattering by singular potentials are proved. First, the scattering amplitude possesses an essential singularity for small coupling constant g and for fixed energy k. Second, for a fixed value g, the S matrix has an essential singularity for large values of energy k. The explicit form of the asymptotic behavior in $|k|$ is given. (auth)

27262 PION PRODUCTION AND THE ONE-PARTICLE-EXCHANGE MECHANISM IN p-p INTERACTIONS AT 3-4 Bev/c. T. Ferbel (Yale Univ., New Haven), A. Firestone, J. Sandweiss, H. D. Taft, M. Gailloud, T. W. Morris, W. J. Willis, A. H. Bachman, P. Baumel, and R. M. Lea. Phys. Rev., 138: B1528-36(June 21, 1965). (BNL-8814)

A study of antiproton-proton collisions at 3–4 Bev/c indicates that about 25% (19 mb) of the total interaction cross section can be attributed to pion production without annihilation. The two outstanding characteristics of the pion-production channels are the strong forward peaking of the antibaryons in the center-of-mass system, and the prominence of the well-known $T = J = \frac{3}{2}$ pion-nucleon resonance $N^*(1238)$ and of its antiparticle in the final states. The cross section for the reaction $p + p \rightarrow \underline{p} + p + p + \pi^+ + \pi^-$ is 3.43 ± 0.23 mb at 3.28 Bev/c and 3.67 ± 0.30 mb at 3.66 Bev/c. This reaction, which is the major channel contributing to the pion-production cross section, is found to be consistent with a one-pion-exchange mechanism. In particular, the theory of Selleri and Ferrari gives a good fit to many aspects of the data. However, a detailed analysis indicates that pion production in proton-antiproton collisions is not totally consistent with a simple one-pion-exchange mechanism. (auth)

27263 SELF-CHARGE-CONJUGATE MESON MULTIPLETS. M. Umezawa (Universite, Strasbourg). Phys. Rev., 138: B1537-41(June 21, 1965).

A kind of self-charge-conjugate meson multiplets is introduced assuming the SU(3) functions of pseudoscalar and vector mesons to be the products of two triplet SU(3) functions. The charge-conjugation property for the operator, frequently denoted by H_3, is defined so that each particle and its antiparticle have the same mass. Then it is shown that one can introduce a linear mass-breaking operator for the nonet mesons. It is found that this linear mass-breaking operator mixes the singlet with the $T = 0$, $S = 0$ member of the octet. This is illustrated by analyzing the masses of pseudoscalar and vector mesons. In this analysis a quadratic mass-breaking operator and the Casimir operator are introduced in addition to the linear mass-breaking operator in order to represent all possible independent vector operators and all possible independent invariant operators. (auth)

27264 SPIN DETERMINATION FOR BOSON RESONANCES. Suh Urk Chung (Univ. of California, Berkeley). Phys. Rev., 138: B1541-5(June 21, 1965). (UCRL-11899)

A method of spin and parity determination was worked out for boson resonances of spin S which decay into a spin-1 particle and a spin-0 particle. It is shown that the quantity $S(S + 1)$ can be given in terms of experimentally measurable averages. This affords a straightforward way of determining the spin uniquely. For the parity assignment, one finds that certain experimental averages are identically zero for one parity case and not the other. In addition, for the parity case in which two orbital angular momenta are allowed, decay parameters as well as multipole parameters for the spin-S particle can be determined. (auth)

27265 HIGH-ENERGY LARGE-ANGLE SCATTERING BY SINGULAR POTENTIALS. George Tiktopoulos (Princeton Univ., N. J.). Phys. Rev., 138: B1550-8(June 21, 1965).

An attempt, based on potential scattering, to understand the recent experimental results on high-energy large-angle proton-proton scattering is presented. Potentials of the form $g\, e^{-i\Delta}\, r^{-n}$, representing strong absorption ($\pi > \Delta \geq 0$; $n \geq 2$) at short distances r ($g > 0$ may depend on the energy), are studied in order to obtain the asymptotic form of the associated scattering amplitude at high energies and fixed (nonforward) angle. This form is found to display the rapid (exponential) decrease of the (elastic) differential cross section with increasing scattering angle which is typical of the p-p experiments. (auth)

27266 COHERENT-STATE REPRESENTATIONS FOR THE PHOTON DENSITY OPERATOR. Kevin E. Cahill (Harvard Univ., Cambridge). Phys. Rev., 138: B1566-76 (June 21, 1965).

The diagonal P representation of the photon density operator in terms of the coherent states of the radiation field is studied. It is shown that the class of weight functions $P(\alpha)$ required to represent all density operators by means of the P representation is much larger than the class of all probability distributions and that therefore the analogy linking the use of the P representation with certain classical stochastic techniques is useful only for a limited class of density operators. The class of density operators for which the P representation is appropriate is shown to be limited in the sense that there are density operators that require weight functions so singular as to lie outside the class of all tempered distributions. Conditions on the weight function $P(\alpha)$ under which the expectation values of the normal ordered operators $(a^\dagger)^n\, a^m$ assume a particularly simple integral form are presented. It is shown that if $P(\alpha)$ is a tempered distribution, then these expectation values are given by a simple limiting process. A limited correspondence with classical optics is suggested by a formula for these expectation values. Conditions that a density operator must satisfy if its weight function is to be non-negative are presented and are shown to exclude all pure states except the coherent states themselves. The problem of representing an arbitrary operator in terms of the coherent states is studied. New measures of the completeness of the coherent states are established. (auth)

27267 CLASSICAL RELATIVISTIC MECHANICS OF INTERACTING POINT PARTICLES. H. Van Dam and E. P. Wigner (Univ. of Wisconsin, Madison). Phys. Rev., 138: B1576-82(June 21, 1965).

The possibility of formulating a classical relativistically invariant mechanics of an arbitrary number of interacting point particles is demonstrated. This theory is similar to Newtonian mechanics inasmuch as the interaction between any pair of particles contains an arbitrary function of their distance. The conservation laws for energy and linear and angular momenta are established in the sense that the sum of these quantities for the particles entering a collision is equal to the corresponding sum for the collision products. The possibility of such a mechanics contrasts with the impossibility, demonstrated recently, of establishing a relativistic mechanics within the framework of the canonical representations of the Lorentz group. (auth)

27268 FORMAL REDUCTION OF FEYNMAN GRAPHS AND ITS POSSIBLE IMPLICATION ON THE ABSENCE OF A DIRECT 5π RESONANCE. Alfred C. T. Wu (Univ. of Michigan, Ann Arbor). Phys. Rev. Letters, 14: 793-4 (May 10, 1965).

It is pointed out that, in perturbation theory, there exists an upper limit on the number N of a system of N particles that can be directly coupled to yield a super-resonance, based on a formal reduction of a class of Feymann graphs, and which implies that a resonance in the 5π system is to be interpreted as at least a two-step process rather than a direct 5π resonance. (L.B.S.)

27269 U(12) AND TIME-REVERSAL ASYMMETRY IN THE WEAK INTERACTIONS. F. Zachariasen and G. Zweig (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 14: 794-8(May 10, 1965). (CALT-68-24)

It is postulated that two U(8) subgroups of U(12) are pertinent symmetries for weak interactions, which, coupled with the $\Delta T = \frac{1}{2}$ rule, leads to a violation of time reversal invariance in the $K^0 + 2\pi$ decay and a branching ratio for the long- to short-lived K^0 component of 2×10^{-4}. The theory requires no T violation in leptonic decays, T violation only in the parity-nonconserving part of the nonleptonic decay, and T-violating effects of order 4% in strangeness-conserving weak nuclear processes, and of order 0.2% in nonleptonic hyperon decays. (L.B.S.)

27270 RELATIVISTIC TREATMENT OF SPIN INDEPENDENCE. K. J. Barnes (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 14: 798-801(May 10, 1965).

A brief survey is given of the difficulties involved in the usual approach to the problem of combining within one relativistic framework the internal symmetries of the strong interactions with their spin independence. A new technique is proposed for combining spin and internal symmetries which is sufficient to treat spin symmetry within the context of a relativistic S-matrix theory dealing with free-particle states and three-particle vertices. (L.B.S.)

27271 KINETIC-ENERGY EFFECTS IN M(12) THEORY. Peter G. O. Freund (Univ. of Chicago). Phys. Rev. Letters, 14: 803-6(May 10, 1965).

An attempt is made to formulate the M(12) theory incorporating the intrinsic symmetry breaking by the kinetic-energy effects. A model of 36 mesons grouped in a 143 representation of M(12) in interaction with six quarks belonging to 12 is considered, and the kineton emission technique is systematically applied to the mass splittings of the mesons. The technique is also applied to vertex functions and scattering amplitudes. A possible connection of the theory of kineton emission with the infinite-dimensional unitary representations of SM(12) is pointed out. It is concluded that incorporating M(12) symmetry-breaking kinetic-energy effects to all orders restores the unitarity of the S matrix but reduces the symmetry to (Poincare group) $\otimes$ SU(3). (L.B.S.)

27272 ANALYSIS OF A_1 PEAK IN THE $\pi\rho$ SYSTEM. N. P. Chang (Rockefeller Inst., New York). Phys. Rev. Letters, 14: 806-10(May 10, 1965).

The reaction $\pi^+ + p \rightarrow \pi^+ + \pi^- + p$ was examined in detail, and it is shown that the interference between the two modes of $\pi^+\rho^0$ production gives a peak at the energy predicted by Pais and Nauenberg using the Peierls mechanism. The predominance of $N^+\rho$ production necessitates the subtraction of N^+ background. The effect of the subtraction on the rate for $\pi\rho$ production is discussed. (L.B.S.)

27273 THE SPECTRA OF ELEMENTARY PARTICLES. Ya. A. Smorodinskii (Joint Inst. for Nuclear Research, Dubna). Priroda, No. 2, 2-12(Feb. 1965). (In Russian)

A brief review is given of the spectra and classification of elementary particles. The properties and structure of atomic nuclei, nucleons, hyperons, baryons, octets resonance mesons, decuplets, and Ω hyperons are discussed. (R.V.J.)

27274 WAVE PACKET THEORY OF SCATTERING. TIME DELAY AND SPREAD. Takashi Ohmura (Stanford Univ., Calif. and Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), Suppl., No. 29, 108-34(1964).

A wave-packet theory of scattering is presented in which time delay (or advance) phenomena are discussed. The wave packet $\psi \rightarrow \int G e^{i\alpha}(e^{ikz} + g e^{i\beta} e^{ikr}/r) e^{-iEt/\hbar} dE$ (G, α, g, and β being real functions of the energy E.) is considered where g exp(iβ) is the scattering amplitude. For elastic scattering it is shown that the observable delay time for incident beams with nearly monochromatic energy E is just half of Wigner's definition of delay time and Smith's collision lifetime, if the phase α(E) of the incident wave packet is a linear function of energy. However, this assumption is largely violated under certain experimental conditions; hence, the delay time is not always given in terms of the scattering matrix elements only. This fact limits the hope that the S-matrix alone can give a space-time description of collision events. The general formula of delay time $\langle\Delta t\rangle$ has the following form: $\langle\Delta t\rangle = \{\int G^2 g^2 [(d\beta/dE) + (d\alpha/dE)]\sqrt{E}dE/\hbar\int G^2 g^2 \sqrt{E}dE\} - [\int G^2 (d\alpha/dE)\sqrt{E}dE/\hbar\int G^2\sqrt{E}dE]$. The observable scattering cross section $\sigma(\theta)$ is given by $\int G^2 g^2 \sqrt{E}dE / \int G^2\sqrt{E}dE$, which is independent of α, unlike the delay time. The spreading of the wave packet in space or time before and after the scattering is considered explicitly. Examples of scattered wave packet are given for resonance scattering with background (so-called potential scattering) phase shift. (auth)

27275 THE RELATION OF THE BOOTSTRAP IDEA TO SYMMETRIES OF STRONG INTERACTIONS. Fredrik Zachariasen (California Inst. of Tech., Pasadena). Progr. Theoret. Phys. (Kyoto), Suppl., No. 29, 135-41(1964).

It is shown that isospin conservation in the π-N system may result from bootstraps, together with the assumptions of charge conservation. A bootstrap model is outlined in which parity conservation may be obtained. (D.C.W.)

27276 OCTET ENHANCEMENT. Rodger F. Dashen, Steven C. Frautschi, Murray Gell-Mann, and Yasuo Hara (California Inst. of Tech., Pasadena). Progr. Theoret. Phys. (Kyoto), Suppl., No. 29, 141-2(1964).

A description of enhancement is outlined for the electromagnetic mass differences, based on the bootstrap theory of strong interactions. (D.C.W.)

27277 PROBLEMS CONCERNING THE SELF-CONSISTENT DETERMINATION OF STRONGLY INTERACTING PARTICLES. Hironari Miyazawa (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., No. 29, 142-3(1964).

The stability of solutions of self-consistent equations is discussed, together with the appearance of zero-mass bosons. (D.C.W.)

27278 BOOTSTRAP PARTICLES AND ELEMENTARY PARTICLES IN THE $Z_3 = 0$ LIMIT. DISCUSSION IN A SOLUBLE MODEL. Satoru Saito and Tomoya Akiba (Tohoku Univ., Sendai). Progr. Theoret. Phys. (Kyoto), Suppl., No. 29, 144-6(1964).

The relation between the bootstrap conditions and the condition of vanishing wave function renormalization constant is discussed in terms of a model which describes the scattering of the Θ-particle by the fixed N-particle through the intermediate V-particle. (D.C.W.)

27279 CABIBBO AXIAL-VECTOR CURRENT AND MESON CLOUD. Mineo Fukawa (Sophia Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), Suppl., No. 29, 147-9(1964).

A model is outlined in which the effective currents of the leptonic decay are described by the Cabibbo currents and in which the meson cloud is taken into account. (D.C.W.)

27280 SYMMETRY OF THE LEPTONS AND THE INTERMEDIATE BOSONS. Seitaro Nakamura (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., No. 29, 150-2(1964).

A variant of the intermediate boson theory is proposed in which the boson interaction is classified in two modes—in a meso-strong coupling constant and in a super-weak coupling constant with the neutrino. (D.C.W.)

27281 REACTION $\pi + N \rightarrow K + \bar{K}$ AND DETERMINATION OF THE COUPLING CONSTANT OF ρ AND K-MESONS. A. C. Yukarev and Yu. G. Pavlenko. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 5, 8-10(Sept.-Oct. 1964). (In Russian)

The $g_{\rho K\bar{K}}$ coupling constant for $\pi + N \rightarrow N + K + \bar{K}$ reaction with $T = 1$ was calculated using the Chew-Low polar approximation. The scattering diagram indicating particles and their momenta were analyzed. The distribution of $(d\sigma/d\Delta^2)$ as ω function$\cdot\Delta^2$ of $K - K^0$ coupling was calculated. (R.V.J.)

27282 A SIMPLE METHOD FOR CALCULATION OF MANY-QUANTUM PROCESSES. P. H. Dederichs and

G. Leibfried (Technische Hochschule, Aachen). Z. Physik, 184: 521-6(1965). (In German)

A simple approximation for n-quantum transitions between spin-Zeeman levels of protons is discussed giving the same result as the calculations of S. Wilking. (auth)

27283 REGGE POLES FOR VELOCITY-DEPENDENT POTENTIALS. M. Weigel (Universitat, Frankfurt am Main). Z. Physik, 185: 186-98(1965). (In German)

The analytical behavior of the scattering amplitude with respect to energy and angular momentum is considered for a group of soluble velocity-dependent potentials. Generalized Jost functions as well as trajectories for the poles are given explicitly. In certain cases the positions of the poles were determined numerically. (auth)

27284 ELECTRON BREMSSTRAHLUNG IN SCATTERING BY NEUTRAL ATOMS CONSIDERING CORRELATIONS BETWEEN COLLISIONS. Yu. P. Raizer. Zh. Prikl. Mekhan, i Tekhn. Fiz., No. 5, 149-51(Sept.-Oct. 1964). (In Russian)

By summing over the momentum changes in each collision in a plasma, the factor $\omega^2/(\omega^2 + \nu_{eff}^2)$ which occurs in the expression for the spectral radiation energy can be derived directly. Here, ν_{eff} is the collision frequency; and ω is the radiation frequency. Formerly this factor could only be obtained indirectly using Kirchof's laws. The new expression contains a correction factor describing the correlation between collisions which occur when ν_{eff} and ω are of the same order of magnitude. (TTT)

27285 EXPERIMENTAL STUDY OF A BASIC MODE DISTRIBUTION IN OPEN RESONATORS WITH SPHERICAL MIRRORS. S. F. Dyubko, V. V. Kamyshan, and V. P. Sheiko (Kharkov State Univ.). Zh. Tekhn. Fiz., 35: 279-81 (Feb. 1965). (In Russian)

Study of the amplitude distribution of the electromagnetic field in open resonators is possible by means of the Q-spoiling effect and use of a low-absorbing element in the resonator. This method can also be used to study basic mode field distribution (without higher mode noise) and the effect on field distribution of mirror misalignment and other inhomogeneities within the resonator. To simplify the theoretical computations, the resonator dimensions were made larger than the wavelength. The radii of curvature of the mirrors was 1250 λ, the maximum diameter was 85 λ, and the distance between mirrors 2l was varied from 1650 to 620 λ. In order to measure the Fresnel numbers for a given distance between reflectors, the latter were coated with black rubber on which large amounts of carbon black had been deposited. The resonator was excited by an open-end waveguide located at the center of one mirror; the other mirror housed a radiation sensor. Measurements were made for confocal resonators for which the distance between mirrors was $2l > r_0$. A satisfactory agreement between theoretical and experimental results was achieved. Introduction of a dielectric into the resonator caused displacement of the field pattern in the direction of the dielectric similar to that produced by misalignment, and nonsymmetrical placement and inhomogeneities of the dielectric resulted in distortion of the field-intensity lines. The Q of the resonator was reduced in the process from 7 to 1×10^5. Although a uniformly distributed inhomogeneity did not affect the field distribution pattern, it caused a considerable decrease in the Q. The method was further checked by introducing an additional, small, but highly absorbing probe-like inhomogeneity into the resonator. The field distribution pattern, plotted with an accuracy to 1–3%, was independent of the position of the additional probe. (ATD)

Field Theory and Quantum Mechanics

Refer also to abstracts 27136 and 27210.

27286 (CEA-R-2603) QUELQUES PROPRIÉTÉS DE LA MATIÈRE AUX TRÈS HAUTES TEMPÉRATURES ET FORTES PRESSIONS (ÉQUATION D'ÉTAT, OPACITÉ). (Some Properties of Matter at Very High Temperatures and High Pressures (Equations of State, Opacity)). André Gervat (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). 1965. 96p. Dep.(mn).

Thesis submitted to Université, Paris.

The Thomas-Fermi equations which are zero-order approximations of the Hartree-Fock equations, make it possible to study some aspects of the behavior of matter at high pressures. In the first chapter the calculation of values which do not require the Schroedinger equation to be solved, is considered. The values of the quantum and exchange corrections give the zone of validity of the theory. For each R and T pair it is possible to calculate the energy and the pressure. For the calculation of the energy, it has been necessary, in the region close to the nucleus where the corrections diverge to replace the density given by the Thomas-Fermi theory by that deduced from the wave functions which, in the small region, are very similar to that of a hydrogen atom of charge z. The calculation of the degree of ionization is particularly simple and does not require the SAHA equations to be solved. Besides the distribution of electrons in the $\vec{r}$ space it is simple to determine the distribution according to the quantum number 1, and this for each value of the R, T pair. In the second chapter, the introduction of the Thomas potential into the Schroedinger equation makes it possible to obtain the energy spectrum of a perfect isolated atom supposed to represent an "average atom" of the hot, compressed matter. The changes in the levels with increasing temperature and pressure can be deduced from this. It is particularly easy with this model to interpret the phenomenon of ionization caused by pressure. A knowledge of the wave functions makes it possible to calculate the transition probabilities which, coupled with the occupation probabilities, lead to the opacity coefficients. Only the bound-free and free-free transitions have been considered but these latter include, because of the properties of the model used, a large part of bound-bound or band-band transitions. Finally, the use of the Thomas-Fermi potential for the calculation of bands is particularly suitable for studying the influence of compressions on the band structure. (auth)

27287 (JINR-P-1960) K FORMULIROVKE KVANTOVOI TEORII SKALYAPNOGO POLYA S SUSHCHESTVENNO NELINEINYM VZAIMODEISTVIEM. (Formulation of a Scalar Quantum Field Theory With Essentially Nonlinear Interaction). G. V. Efimov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 16p. Dep.(mn).

In scalar quantum field theory with a local, essentially nonlinear interaction a method is suggested of constructing an S-matrix which is finite in all orders of perturbation theory. The construction is made for the amplitudes of physical processes in the Euclidean region of space-like external momenta. It is shown that there is a principal nonuniqueness arising in the formulation of the problem. (auth)

27288 (JINR-P-1961) REGULYARIZATSIYA NEPERENORMIRUEM'KH TEORII. (A Regularization of Nonrenormalizable Theories). G. V. Efimov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 17p. Dep.(mn).

A scalar quantized field with a nonrenormalizable interaction lagrangian is treated. The theory is formulated originally in Euclidean space, where the regularization of the causal function is performed. This regularization removes all the divergences in the theory. It is shown that analytic continuation to the physical region does not violate the conditions of unitarity, locality, and causality. It turns out that the amplitudes of the physical processes have an essential singularity at infinity in the energy variable. (auth)

27289 (NP-14849) LECTURES ON A MODIFIED MODEL OF EUCLIDEAN QUANTUM FIELD THEORY. Matscience Report 35. K. Symanzik. Notes by K. Venka-

tesan and T. K. Radha (Institute of Mathematical Sciences, Madras (India)). [1964]. 76p. Dep.(mn).

The properties of Euclidean quantum field theory are studied. The study is in the form of a series of lectures, in which are examined: axiomatic formulations and general considerations; models and modifications; the Friedrichs-Shapiro integral; the regularized Yukawa operator; general properties of solutions; and particular properties of solutions. (T.F.H.)

27290 (JPRS-29075(p.48-55)) QUANTUM PREDICTION OF RANDOM ELECTROMAGNETIC PROCESSES. V. V. Mityugov. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 848-53(Sept.-Oct. 1964).

Formulas are obtained for the extrapolation of electromagnetic field intensities from mean values from measurement at a series of points in the space-time domain. The derivation is based on the principle of maximum disinformation using the operational determination of entropy. Formulas are obtained for the quantity of information associated with such a measurement and with the concrete realization of a random process of given spectral power within a finite time interval. (auth)

27291 FERMI ACCELERATION MECHANISM IN THE ONE-DIMENSIONAL CASE. G. M. Zaslavskii and B. V. Chirikov (Novosibirsk State Univ., USSR). Dokl. Akad. Nauk SSSR, 159: 306-9(Nov. 11, 1964). (In Russian)

The possibility of net acceleration of a body from random collisions with other bodies (Fermi acceleration) is of interest because of the possibility of transfering energy from astronomical bodies to space vehicles. A one-dimensional model of this process is the motion of a small body between two infinite parallel planes, one of which oscillates with an amplitude a and a maximum velocity V. It is shown that the velocity of the small body v can only be treated stochastically when a discriminant $\Omega^2 = \mathfrak{L}V^2/16av^2 \gg 1$. Here $\mathfrak{L}$ is the total distance between the planes ($\mathfrak{L} \gg a$). For the stochastic case equations can be derived for a distribution function f(v,t), where t is time. (TTT)

27292 POLAR FERMI-LIQUID MODEL. S. G. Kadmenskii (Voronezh State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 334-8(Feb. 1965). (In Russian)

An attempt is made to introduce approximations into the theory of a Fermi liquid which 1) would be independent of perturbation theory and thus valid for all densities; 2) would be valid in the asymptotic cases of high and low density; and 3) would explain the apparently unjustified success of the Brueckner and Hartree-Fock models. Calculations are based on the assumptions that the energy and its first two variational derivatives with respect to the quasiparticle distribution function are smooth functions of the particle density and that the difference between the kinetic energy of the interacting Fermi particles and that of a free Fermi gas of the same density is small compared with the interaction potential energy of the particles. An expression is derived for the ground state energy of a Fermi liquid, which is similar to those obtained by the Brueckner and the Hartree-Fock methods, but which involves the scattering amplitude in vacuo. The assumption concerning the kinetic energy is shown to be valid for the electron gas in a metal, and its validity in the case of nuclear matter and liquid ^{3}He is discussed. It is shown that the kinetic energy assumption is valid provided the renormalization constant is nearly unity and the nonpolar part of the Green's function can accordingly be neglected. The applicability of the resulting polar approximation to the nuclear model of Migdal is discussed briefly. (ATD)

27293 ON "DIAGONAL" COHERENT-STATE REPRESENTATIONS FOR QUANTUM-MECHANICAL DENSITY MATRICES. John R. Klauder (Bell Telephone Labs., Inc., Murray Hill, N. J.), James McKenna, and Douglas G. Currie. J. Math. Phys. (N. Y.), 6: 734-9(May 1965).

It is proved that every density matrix is the limit, in the sense of weak operator convergence, of a sequence of operators each of which may be represented as an integral over projection operators onto coherent states (in the sense of Glauber) with a square-integrable weight function. This result is a special case of one that holds for all operators with trace and for overcomplete families of states other than just the coherent states. This more general result is proved at no cost of complexity, within the more general framework of continuous-representation theory. The significance of these results for representing traces of operators is indicated. (auth)

27294 S-OPERATOR THEORY. I. FORMULATION. Robert E. Pugh (Univ. of Toronto). J. Math. Phys. (N. Y.), 6: 740-6(May 1965).

It is postulated that the S operator is dynamically independent of the wavefunctions of the asymptotic states. From this postulate a functional differential equation for the S operator is developed. Its solutions include both the renormalized and unrenormalized Feynman–Dyson S operators; appropriate boundary conditions distinguish the two solutions. Interpolating quantum fields are defined in terms of the S operator and are only of secondary importance in this theory. Calculations in this theory are not appreciably more difficult than the corresponding calculations with the unrenormalized S operator. (auth)

27295 MULTIPOLE MATRIX ELEMENTS OF THE TRANSLATION OPERATOR. M. Danos and L. C. Maximon (National Bureau of Standards, Washington, D. C.). J. Math. Phys. (N. Y.), 6: 766-78(May 1965).

Formulas are given for the expansion of multipole fields of arbitrary tensorial character into multipole fields about a shifted origin. The expansion coefficients are given as matrix elements of the translation operator. In analogy to the matrix elements of the rotation operator, a standard form is introduced for these matrix elements which represents a parallel displacement of the coordinate system along the z axis. Any arbitrary translation of the coordinate system then consists of a consecutive application of a rotation, a standard translation, and a rotation. Since the multipole fields form a complete set any arbitrary function can in principle be expressed in a shifted coordinate system by means of the given formulas. All mathematical derivations are given. (auth)

27296 LAGRANGIAN THEORY FOR THE SECOND-RANK TENSOR FIELD. K. J. Barnes (Cornell Univ., Ithaca, N. Y.). J. Math. Phys. (N. Y.), 6: 788-94(May 1965).

The second-rank tensor field $\phi^{\mu\nu}$ is decomposed into its various subspaces under the Lorentz group and the appropriate projection operators are exhibited explicitely. The most general local, Hermitian, free-field lagrangian which can be formed from this field is written down, and the corresponding equations of motion and subsidiary conditions are derived by means of a variational principle. Finally some possible applications of this theory are discussed (in particular spin-2 boson theory), and all the possible couplings of this field to a Dirac particle are listed in full. (auth)

27297 ONE-PARTICLE TRANSITIONS AND CORRELATION IN QUANTUM MECHANICS. A. R. Ruffa. J. Res. Natl. Bur. Std., 69A: 167-80(Mar.-Apr. 1965).

The quantum mechanical correlation problem, involving the evaluation of expectation values of many-particle operators for a given eigenstate, was formulated, by means of the matrix sum rule, in terms of unobservable or virtual one-particle transitions to other eigenstates of the system. This formulation is set forth to demonstrate the nature of the many-particle correlations from the point of view of matrix mechanics and to make possible the derivation of sum rules, which may be used in their analysis. The analysis showed that the transition integrals $\langle\alpha|A_i|\alpha'\rangle$ and $\langle\alpha|A_j|\alpha'\rangle$, where A_i and A_j are arbitrary one particle operators involving the ith and jth particles, respectively, are not necessarily equal, since such transitions can involve quantum states of different coordinate symmetry, i.e., the antisymmetric and symmetric states when $N = 2$, and the states of mixed symmetry, in addition, when $N \geq 3$. The indistinguishability principle is demonstrated to require only that $\Sigma_{\alpha'}|\langle\alpha|A_i|\alpha'\rangle|^2 = \Sigma_{\alpha'}|\langle\alpha|A_j|\alpha'\rangle|^2$. By detailed analysis of one-particle transitions to states of

various symmetries, the relationship between the various one-particle transitions was determined. The expectation value for an antisymmetric state of the two particle operator $\Sigma_{i\neq j} A_i \cdot A_j$ was found to be $\Sigma_{i\neq j}\langle\alpha|A_i \cdot A_j|\alpha\rangle = N(N-1)\Sigma_{\alpha'_A}|\langle\alpha|A_1|\alpha'_A\rangle|^2 - N\,\Sigma_{\alpha'_N}|\langle\alpha_A|A_1|\alpha'_N\rangle|^2$, where the sum α'_A is over all antisymmetric states, and the sum α'_N is over all the nonantisymmetric states. This equation was used to obtain an approximate relation between these expectation values and observable quantities. From the Heisenberg commutation relations, the sum rule $\sum_{\alpha'=1}^{N}\Sigma_{\alpha'}(E_{\alpha'}-E_\alpha)|\langle\alpha|r_1|\alpha'\rangle|^2 = 3\hbar^2N/2m$ was obtained and used to demonstrate some general properties of systems in the nonrelativistic approximation. (auth)

27298 ON THE PROBLEM OF MOTION IN NON-LINEAR ELECTRODYNAMICS. H. Fuchs. Monatsber. Deut. Akad. Wiss. Berlin, 6: 818-20(1964). (In German)

The equation of motion of a charged particle in a constant electromagnetic field is derived. The Lagrange function, which is non-linearly dependent on the field invariants and which is transformed into the Maxwell-Lagrange function in weak fields, also finally leads to an equation of motion containing the physically meaningful term of radio-reaction. (CFSTI)

27299 SECOND ORDER APPROXIMATION OF THE THREE-DIMENSIONAL TRAJECTORIES OF CHARGED PARTICLES IN DEFLECTING ELECTROSTATIC AND MAGNETIC FIELDS. H. Wollnik (Justus Liebig Universitat, Giessen, Ger.). Nucl. Instr. Methods, 34: 213-21(May 1965).

The radial trajectories of charged particles in electric and magnetic fields between toroidal electrodes and pole-faces are known in a second order approximation, if the trajectories under consideration do not deviate very much from a circular main path. The axial trajectories of charged particles are newly derived in a second order approximation and presented together with the radial trajectories. (auth)

27300 THE EQUATIONS OF MOTION OF SLOWLY MOVING PARTICLES IN THE GENERAL THEORY OF RELATIVITY. M. Carmeli (Israel Inst. of Tech., Haifa). Nuovo Cimento (10), 37: 842-75(June 1, 1965).

The equations of motion of slowly moving particles in a harmonic coordinate system are obtained up to an accuracy of the 9th order in c^{-1}, where c is the velocity of light. This is done for the two-particle case, and is an extension of the familiar Einstein, Infeld and Hoffmann (EIH) equations of motion, which hold up to an accuracy of the 6th order in c^{-1}. However, the method of obtaining the equations of motion is essentially different from the EIH method, in that the retarded-potential solutions for the wave equations are chosen rather than the symmetric potentials; a radiative force term is thus obtained. The method is based on the assumption that the metric tensor of the space-time differs from the Minkowskian metric by perturbations, which can be expanded in a power series in the masses of the particles. The passage to the low-velocity case is made by every function of the field being expanded in a power series in c^{-1}. Throughout this work the Infeld delta-function was used; it is shown that the field functions at the 8th order do not obey the rule for tweedling the products, as has so far been assumed by Infeld. The equations of motion so obtained are very complicated; it is found that the choice of the potentials (retarded or advanced) affects them only in the 9th order, that the force term corresponding to the dipole radiation (namely the 7th order term) vanishes, and that the force terms up to the 6th order are identical with those of the EIH equations. It is remarkable that, by repeated use of the equations of motion, one can reduce them to a form containing derivatives (with respect to time) no higher than the second. A discussion on this method and comparisons with other methods are given. (auth)

27301 CONSERVATION LAWS AND INVARIANCE PRINCIPLES. D. B. Fairlie (St. Andrews Univ., Fife, Scotland, U. K.). Nuovo Cimento (10), 37: 897-904(June 1, 1965).

The infinite sequence of conserved quantities which were recently discovered in free-field theories by Kibble, are shown to be a consequence of translation invariance and the quadratic nature of the lagrangian. This observation leads to a natural extension of Kibble's work by exploiting the full Lorentz invariance of the free-field equations, leading to the construction of further new conservation laws. The question whether the existence of a conservation law implies an invariance of the lagrangian is raised and answered in the negative. (auth)

27302 CAUSAL QUANTUM MECHANICS WITH PHASE AND PARTICLE VELOCITIES EQUAL. J. P. Wesley (Univ. of Missouri, Rolla). Nuovo Cimento (10), 37: 989-1003(June 3, 1965).

A relativistic theory of causal quantum mechanics for a scalar particle is proposed in which the phase velocity is equal to the particle velocity. A particle is viewed as a classical point particle that moves along a wave normal attached to a surface of constant phase. A prescription is derived for the particle trajectories in a standing wave which gives rise to periodic motion in the bound-particle case. The old quantum theory of Bohr and Sommerfeld is obtained in the geometrical-optics approximation. The observed particle density is the wave intensity (in agreement with $\Psi\Psi^*$ of the traditional theory). The problems of a free particle, a particle reflected from a mirror, and the simple harmonic oscillator are considered. (auth)

27303 ON AN UNCERTAINTY RELATION FOR ANGULAR VARIABLES. M. Bouten, N. Maene, and P. Van Leuven (Studiecentrum voor Kernenergie, Mol. Belg.). Nuovo Cimento (10), 37: 1119-25(June 1, 1965).

A proof is given of an uncertainty relation for angular variables, which has recently been conjectured by Judge (Nuovo Cimento, 31: 332(1964)). (auth)

27304 SOME CONSIDERATIONS ON THE BOUNDARY CONDITIONS FOR FUNCTIONAL DIFFERENTIAL EQUATIONS. T. Yoshimura (Univ. of Nijmegen, India). Nuovo Cimento (10), 37: 1160-4(June 1, 1965).

In order to determine the propagators from the functional differential equation, it is not sufficient to give a boundary condition for the identically vanishing external source. (auth)

27305 THE QUANTIZATION OF FIELDS WITH MAXIMUM SPIN $^3/_2$ AND THE APPLICATION TO SU_{12}. L. Castell (Trinity Coll., Dublin). Nuovo Cimento (10), 37: 1236-8(June 1, 1965).

The linear Lorentz invariant field equation of first order that describes the space-time symmetry of the baryons (i.e., the spin-$^3/_2$ decuplet and the spin-$^1/_2$ octet) in the SU_{12} scheme of strong interactions is considered. It is shown that three different irreducible field equations are involved in quantizing this equation. The canonical rule of field quantization is used. The commutation relations and Green's function that are obtained are discussed. (C.E.S.)

27306 SELECTION RULES FOR PARAFIELDS AND THE ABSENCE OF PARA PARTICLES IN NATURE. O. W. Greenberg (Univ. of Maryland, College Park) and A. M. L. Messiah. Phys. Rev., 138: B1155-67(June 7, 1965).

Green's parafield quantization is reviewed. It is shown, both for a single field and for sets of fields, that all Fock-like representations of Green's trilinear commutation rules are realized by Green's ansatz with anti-commuting (commuting) Bose (Fermi) component fields for para-Bose (para-Fermi) fields. Restrictions on the form of the interaction Hamiltonian density $H_I(x)$ are derived from the requirement that $H_I(x)$ be a paralocal operator. From these restrictions on H_I, selection rules on the S matrix are proved to all orders of perturbation theory. The most important such rule prohibits all reactions in which the total number of para particles of order $p > 1$ in the initial and final states is one. This last selection rule, together with experimental information, leads to the conclusion that no presently known particle can be para. (auth)

27307 BROKEN SYMMETRY IN QUANTUM ELECTRODYNAMICS AND ZERO-MASS BOSONS. R. Acharya and P.

Narayanaswamy (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 138: B1196-7(June 7, 1965).

The recent attempt of Baker, Johnson, and Lee at proving the existence or otherwise of zero-mass bosons in quantum electrodynamics with vanishing bare-electron mass is re-examined. It is argued that the renormalized vertex operator Γ_5^5 exists provided that the electron-pseudoscalar-boson vertex renormalization constant vanishes. No conclusion about the existence or otherwise of zero-mass bosons can be reached within the framework of their high-energy approximation. (auth)

27308 APPROACH TO EQUILIBRIUM OF A RELAXING SYSTEM. I. CLASSICAL 3-LEVEL SYSTEM. Jayaseetha Premanand (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 138: B1320-2(June 7, 1965).

A complete investigation of the properties of a classical stochastic three-level system is made. The existence of a circulatory probability current is deduced for the system considered. A geometrical representation for the probability vector in the case of complex eigenvectors is given, and it is further shown that the probability vector reaches the equilibrium state asymptotically, sweeping smaller and smaller areas of a spiral as $t \to \infty$, irrespective of what "state" one starts with. (auth)

27309 BROWNIAN-MOTION MODEL OF NONRELATIVISTIC QUANTUM MECHANICS. G. G. Comisar (Aerospace Corp., El Segundo, Calif.). Phys. Rev., 138: B1332-7 (June 7, 1965).

In Feynman's space-time approach to nonrelativistic quantum mechanics, the wave function may be considered to be the sum of path integrals over Brownian-motion trajectories. This formalism is entirely equivalent to the Schrödinger-equation treatment with its intrinsic indeterminacy. Pursuing the analogy with Brownian motion further, one may introduce a hidden variable corresponding to particle velocity in order to represent the wave function as a sum of path integrals taken over phase-space trajectories. By means of a hidden parameter corresponding to the time scale of fictitious interactions of the particle with the vacuum, one can define generalized propagators which over very short times produce wave functions which are localizable in phase space and hence are deterministic. For long times the conventional Feynman formalism is recovered. This short-time causality does not violate the von Neumann injunction against hidden variables since the new velocity variable turns out to be non-Hermitian over the long time scales normally considered. In contrast to the models proposed by Bohm and others, the present Brownian model is linear and preserves the usual statistical interpretation of the wave function for sufficiently long times. (auth)

27310 NONPERTURBATIVE CALCULATION OF Z_3 IN MASSLESS ELECTRODYNAMICS. Y. Frishman (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 138: B1450-6(June 21, 1965).

The asymptotic behavior of the vertex function $\Gamma_\mu(p + l, p - l)$ for high $p(p^2 \to -\infty)$ is found for massless bare-fermion electrodynamics. Those terms which contribute to the leading terms of Z_3^{-1} are calculated by a nonperturbative method. This leads to $Z_3 = 0$. (auth)

27311 INELASTIC N/D PROBLEMS AND CASTILLEJO-DALITZ-DYSON CUTS. James B. Hartle and C. Edward Jones (Princeton Univ., N. J.). Phys. Rev. Letters, 14: 801-3(May 10, 1965).

The solutions to the Fyre-Warnock equations are analytically continued to lower values of angular momentum l, and it is found that Castillejo-Dalitz-Dyson cuts are introduced into the D function, which emerge gradually from the inelastic cuts as l is decreased. It is shown that a necessary condition that the Fyre-Warnock equations give the many-channel result for the amplitude A_{11} is that there be no zeros of the scattering matrix S_{11} on the physical sheet which retreat into the inelastic $1 \to \infty$. (L.B.S.)

27312 SPATIAL ISOTROPY AND GRAVITATIONAL RADIATION. S. N. Pandey and S. C. Gaindhar (Univ. of Roorkee, India). Univ. Roorkee Res. J., 7: No. 1-2, Pt. 8, 1-7(1964).

The possibility that non-static isotropic gravitational fields can be regarded as radiation fields is investigated. (D.C.W.)

27313 TO THE QUESTION OF SYMMETRY OF NONLINEAR SPINOR EQUATIONS. G. K. Tshepurnych. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 5, 54-7(Sept.-Oct. 1964). (In Russian)

The selection of nonlinear terms in non-linear classical spinor field theory was analyzed. The s-invariability of the nonlinear classical spinor field equation was studied, and it is shown that s-invariability equations have a symmetric solution ψ and $\psi^c = C \cdot \bar{\psi}^T$ corresponding to the positive and negative energy. The s-invariability of equations in classical cases denotes the theoretical symmetry in relation to the sign of the energy. (tr-auth)

27314 MUST QUANTAL WAVE FUNCTIONS BE SINGLE-VALUED? Martin Kretzschmar (Florida State Univ., Tallahassee). Z. Physik, 185: 73-83(1965).

It is shown that the usual requirement of single-valuedness for angular momentum eigenfunctions is not a necessary consequence of some basic physical principle, but rather a pure convection that prescribes the use of only the simplest mathematical representation that is available. Multi-valued wave functions arise in a natural way, when the discussion starts off from an abstract Hilbert-space approach. The relevance of these considerations for the theory of the Aharonov-Bohm effect is pointed out. (auth)

27315 AHARONOV-BOHM SCATTERING OF A WAVE PACKET OF FINITE EXTENSION. Martin Kretzschmar (Florida State Univ., Tallahassee). Z. Physik, 185: 84-96 (1965).

The scattering of an electron from a thin, shielded solenoid (Aharonov-Bohm effect) is studied by means of the time-dependent Green's function of the problem. The structure of the Green's function reveals in a lucid way the nonidentity of canonical and kinetic angular momentum as the origin of the Aharonov-Bohm scattering. The time development of a Gaussian wave packet is studied in some detail to investigate the validity of certain objections against the original work of Aharonov and Bohm. Results are given for the case of finite radius of the solenoid and finite shielding potential. (auth)

27316 ON THE AHARONOV-BOHM EFFECT FOR BOUND STATES. Martin Kretzschmar (Florida State Univ., Tallahassee). Z. Physik, 185: 97-110(1965).

The following model is discussed: A charged particle is bound by some potential to the origin of a coordinate system in three-dimensional space, while a shielded magnetic flux threads an axis through the origin, thus producing an Aharonov-Bohm effect. The hamiltonian, boundary conditions, wave functions, and energy levels for this model are derived, and in particular the properties of the operators of kinetic angular momentum are discussed. The results obtained shed new light on some more general questions pertaining to boundary conditions and to the theory of angular momentum. (auth)

27317 QUANTUM ELECTRODYNAMICS. A. I. Akhiezer and V. B. Berestetskii. Authorized English Edition Revised and Enlarged by the Authors. Translated from the Second Russian Edition by G. M. Volkoff. Interscience Monographs and Texts in Physics and Astronomy. Volume XI. New York, Interscience Publishers, 1965. 887p.

A systematic treatment of electromagnetic processes is presented on the basis of invariant perturbation theory. The quantum mechanics of electrons and photons, quantization of electron-positron and photon fields, electron-photon interactions, interactions between two charges, the scattering matrix, radiative corrections, and the electrodynamics of spin-zero particles are covered. (D.C.W.)

Geophysics

Refer also to abstracts 26508 and 27059.

27318 (AD-602884) KIRUNA GEOPHYSICAL DATA. Data Summary 63/3, July–September 1963. (Kungliga

Vetenskapsakademien, Kiruna (Sweden). Geofysiska Observatoriet). 56p. $3.00(CFSTI).

A collection of results of measurements carried out at Kiruna Geophysical Observatory is presented. The objective of the data summary is to present current geophysical data related to polar upper atmosphere conditions. The coordinates of the Observatory are 67.8 degrees N, 20.4 degrees E, geographically, and 65.3 degrees N, 115.5 degrees E, geomagnetically. (auth)

27319 (LA-3129) RADAR ATTENUATION DUE TO DELAYED γ RAYS FROM HIGH-ALTITUDE NUCLEAR EXPLOSIONS. R. C. Mjolsness and A. G. Petschek (Los Alamos Scientific Lab., Univ. of California, N. Mex.). July 1964. Contract W-7405-eng-36. 54p. Dep.; $3.00 (cy), 1(mn) CFSTI.

The theory of enhanced radar attenuation due to nuclear explosions is developed for radar paths outside the fireball region and for ionization produced by delayed γ rays. The basic equations are discussed and a number of neglected effects are shown to be small in most cases. Values of parameters entering the equations are given and their justification is discussed in detail. It is shown that the radar attenuation may be expressed as a single integral over the radar path. An extensive asymptotic evaluation of the integral is given and applied to a rough parametric study of the attenuation phenomena. (auth)

27320 (P-1089(RAND)) ELECTRON DENSITY DISTRIBUTION IN A NEW MODEL OF THE IONOSPHERE. H. K. Kallmann (RAND Corp., Santa Monica, Calif.). May 15, 1957. 11p. (AD-606384). $1.00(CFSTI).

A brief outline is given of the theoretical analysis which led to a model of the ionosphere. The results obtained are presented, and theoretical results are compared with direct observations obtained by means of rockets. (auth)

27321 (NASA-TT-F-315) THE UPPER LAYERS OF THE ATMOSPHERE. I. A. Khvostikov. Translation of "Vysoliye Sloi Atmosfery," Gidrometeorologicheskoye Izdatel'stvo, Leningrad, 1964. 587p. $8.85(CFSTI).

This book presents an exposition of contemporary scientific knowledge of the upper layers of the atmosphere. Studies of the structure and composition of the upper layers and of winds, tidal phenomena, etc., are reviewed. The theory of some phenomena and atmospheric processes and the effects of the sun are considered. (D.L.C.)

27322 ON THE CHANGES IN THE D-REGION DURING FLARES ACCORDING TO SEA. L. Krivsky (Inst. of Astronomy, Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 16: 126(1965).

The evaluation of electron density variations in the D-region during a flare from recordings of sudden enhancements of atmospherics (SEA) is discussed, with emphasis on the evaluation of the time-lag between the maximum of SEA effects and that of flare intensity. (D.C.W.)

27323 GALACTIC HYDROGEN AS A HAZARD IN AURORAL SPECTROSCOPY. L. E. J. Montbriand (Defence Research Northern Lab., Fort Churchill, Manitoba). Can. J. Phys., 43: 782-92(May 1965).

Hydrogen emissions from diffuse galactic nebulae in the Milky Way region were found to interfere seriously at times with studies of the occurrence of auroral hydrogen emissions made with patrol spectrographs. Charts were prepared in which the brightness of galactic hydrogen is plotted in galactic coordinates as contour lines of constant brightness in Rayleighs. This presents the information available from the astronomical literature in a form suitable for use in upper atmosphere spectroscopy. (auth)

27324 SATELLITE STUDIES OF ISOLATED IONOSPHERIC IRREGULARITIES. R. M. Turnbull and P. A. Forsyth (Univ. of Western Ontario, London, Can.). Can. J. Phys., 43: 800-17(May 1965).

Ground-based observations of the radio signals propagated through the ionosphere from artificial satellites provide useful information about ionospheric irregularities. The technique has been extended to include recordings of the relative phase of the radio waves received at two stations as well as the customary amplitude recordings. This additional information is useful in interpreting the records. In particular, when relatively isolated single irregularities occur, a rather complete physical description can be derived, including the location of each irregularity in three dimensions and a quantitative electron-density profile for the irregularity. (auth)

27325 SUPERSONIC MOTION OF A BODY IN PLASMA. A. V. Gurevich and L. P. Pitaevskii (Lebedev Inst. of Physics, Moscow and Inst. of Physical Problems, Academy of Sciences, USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 637-42(1964).

Various approximate methods of computing ion concentration at great distances from a body moving rapidly in plasma are compared. A dimensionless equation is obtained, describing the disturbance of plasma behind the body. A similarity law of such motions is formulated. (auth)

27326 IONOSPHERIC INVESTIGATIONS ON THE SCHOONER ZARYA: THE F_2-LAYER IN THE EQUATORIAL REGION. N. P. Ben'kova and K. N. Vasil'ev (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 656-60(1964).

The spatial distribution of the F region is examined on the basis of ionospheric observations on the vessel Zarya from 1959 and 1960. (auth)

27327 DISTRIBUTION OF ELECTRON DENSITY WITH NORMAL AND ANOMALOUS IONIZATION IN THE SUB-ARCTIC REGION. N. I. Potapova and L. A. Yudovich (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 661-8(1964).

The vertical distribution of ionization on quiet days at Salekhard station in all seasons of 1958 is examined. The characteristics of anomalous ionization in winter, when the ionosphere is not illuminated by the sun, are investigated in detail. (auth)

27328 VARIOUS TYPES OF DEPENDENCIES OF f_0F_2 ON SOLAR ACTIVITY. T. N. Vasil'eva and T. S. Kerblay (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 669-71(1964).

The dependence of f_0F_2 on solar activity R for R from 0 to 200 is analyzed on the basis of data from the world network of ionospheric stations. Three types of dependencies are examined: the linear function f_0F_2 of R in the entire range of R; the limitation of the increase of f_0F_2 at high solar activity; and the increase in the growth of f_0F_2 with high solar activity. The pattern of appearance of these types is examined. The possible applications of the conclusions derived to the computation of F_2-muf on a computer are indicated. (auth)

27329 SOME RESULTS OF INVESTIGATIONS OF THE E_s LAYERS IN THE PACIFIC OCEAN AREA. Yu. S. Korobkov and V. V. Pisareva (Gorkii State Univ., USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 672-7 (1964).

The results are presented of investigations of the E_s layer on the basis of observational data for the summer of 1962 in the Pacific Ocean area. The diurnal relations between frequency of occurrence, critical frequency, and screening frequency of the E_s layers were determined for different latitude intervals. Also given is the latitude dependence of the frequency of occurrence of the maximum diurnal values of the critical frequency and transparency for different types of E_s, characteristic of the particular season investigated. (auth)

27330 WINTER DISTRIBUTION OF ELECTRON DENSITY IN THE IONOSPHERIC D REGION. G. Nesterov and K. Serafimov (Inst. of Geophysics, Academy of Sciences, Bulgaria). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 678-83(1964).

The possibility is investigated of determining the coef-

ficients for expansion into a Taylor series of the electron concentration distribution in the D region. Expressions of integral coefficients in a series for nondeviative absorption L are given. The determination of the $N_D(z)$ profile by obtaining absorption at n frequencies by the A_3^* method is applied to winter conditions over Southeastern Europe. The profiles determined have an ill-defined maximum, the position of which correlates with the zenith angle of the sun. (auth)

27331 CHANGE OF AURORAL FORMS WITH A CHANGE OF SOLAR ACTIVITY. N. I. Dzyubenko (Kiev State Univ.). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 737-8(1964).

The variation of auroral forms with solar activity was studied. It was found that, with a decrease of solar activity, the percentage of rayed auroras decreases, while the percentage of quiescent diffuse forms (homogeneous arcs and bands, glow, and patches) increases. No great changes of brightness or frequency of occurrence were noted. Auroras did, however, occur at higher latitudes with a decrease in solar activity. (D.C.W.)

27332 THE WINTER ANOMALY IN THE E_s LAYER. K. Bishoff (Heinrich Hertz Inst., Berlin). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 739-40(1964).

It was previously observed that the midday values of the critical frequency of the E-region were higher than the corresponding values for July. This anomaly is interpreted as the true winter anomaly of the E-layer. (D.C.W.)

27333 HEIGHT OF THE E_s LAYER. N. I. Potapova and M. L. Shevko (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 741-3(1964).

The height of the sporadic E-layer was investigated on the basis of data obtained by vertical sounding of the ionosphere. The analysis of the data showed a tendency for the formation of the layer at a number of preferential heights. (D.C.W.)

27334 STRUCTURE OF THE SPORADIC E LAYER OF THE IONOSPHERE. O. Ovezgel'dyev (Div. of Geophysics and Seismology, Academy of Sciences, Turkmen SSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 744-6(1964).

The variations of the critical frequency, screening frequency, and height of the sporadic E-layer with time were investigated in a series of continuous measurements during the period from April through May, 1963. (D.C.W.)

27335 SOME ASPECTS OF MEASUREMENT BY THE APPLETON METHOD OF THE EFFECTIVE NUMBER OF IONOSPHERIC ELECTRON COLLISIONS. Yu. V. Berezin (Moscow State Univ.). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 747-50(1964).

In the Appleton method, the number of collisions is determined from measurements of difference of the coefficients of absorption and the group path of radio signals at two nearly equal frequencies. The difficulties with this method, particularly for the F_2-layer, are discussed, together with some measurements on the F_2-layer using three radio signals and the collision values obtained. Frequency and altitude dependences are considered. (D.C.W.)

27336 TRAPPED PROTONS IN THE SOUTH ATLANTIC MAGNETIC ANOMALY, JULY THROUGH DECEMBER 1961. 1. THE GENERAL CHARACTERISTICS. G. F. Pieper, C. O. Bostrom, and A. J. Zmuda (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 70: 2021-33(May 1, 1965).

Protons in the range 1 Mev < E < 15 Mev and E > 40 Mev were observed at 1000 km by the Injun 1 satellite (1961) in the vicinity of the South Atlantic magnetic anomaly in the period from July to December, 1961. Around São José dos Campos, Brazil, the unidirectional intensity for the 1- to 15-Mev protons is 100 protons/cm^2 sec ster at $L \approx 1.20\ R_e$ and rises to 7500 cm^2 sec ster at $1.65 < L < 1.80\ R_e$. Near Salisbury, Southern Rhodesia, this flux is 40 cm^2 sec ster at $L \approx 1.20\ R_e$ and rises to a constant value of about 5000 cm^2 sec ster at $1.80 < L < 2.60\ R_e$. For the particles with E > 40 Mev near São José dos Campos the omnidirectional flux is 2000 protons/cm^2 sec at $L \approx 1.20\ R_e$, rises sharply to a maximum of about 5500 cm^2 sec at $L \approx 1.35\ R_e$, and then decreases to about 200 cm^2 sec at $L \approx 1.80\ R_e$. Near Salisbury these high-energy protons have a flux of about 150 cm^2 sec at $L \approx 1.20\ R_e$, rise to a broad maximum of 600 to 800 cm^2 sec at $1.30 < L < 1.60\ R_e$, and then decrease monotonically to the galactic cosmic-ray background of about 2 cm^2 sec at $L \approx 2.5\ R_e$. The differences in the fluxes seen from the two stations arise from the lower magnetic field existing over São José dos Campos and the associated consequences in the dynamics of geomagnetically trapped particles. At higher L values the proton fluxes from the individual stations show a spectral steepening with L, characterized by an increasing intensity of 1- to 15-Mev protons and a decreasing intensity of protons with E > 40 Mev. The trapped particles have temporal stability over the period considered. In general, the magnitudes of the fluxes are in good agreement with previously reported measurements. (auth)

27337 TRAPPED PROTONS IN THE SOUTH ATLANTIC MAGNETIC ANOMALY, JULY THROUGH DECEMBER 1961. 2. COMPARISONS WITH NERV AND RELAY 1 AND DISCUSSION OF THE ENERGY SPECTRUM. C. O. Bostrom, A. J. Zmuda, and G. F. Pieper (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 70: 2035-43(May 1, 1965).

The spatial distribution and energy spectrum of trapped protons observed by Injun 1 (1961) are in agreement with the suggestion that low-energy protons found at L > 1.6 result from the radioactive decay of neutrons produced in the polar atmosphere by solar protons. Large fluxes of 1- to 15-Mev protons are found as low as L = 1.4, however, indicating that several modifications are required in Lenchek's model for the Nerv results. These modifications are discussed qualitatively. The Injun 1 fluxes of 1- to 15-Mev protons agree with the Relay 1 fluxes of 1.1- to 14-Mev protons in the region $1.6 < L < 1.9$ earth radii and $0.20 < B < 0.24$ gauss, and are reasonable extrapolations of the Relay 1 data into the region $1.9 < L < 2.5$ and $0.22 < B < 0.25$, indicating a temporal stability for these protons for the period July 1961 to January 1963. Comparing the flux contours determined by several investigators with Injun 1 detectors shows clearly that more than one particle source mechanism must be invoked. The high energy (E > 40 Mev) protons and the low energy ($E \lesssim 1$ Mev) protons or ions of comparable rigidity have a similar spatial distribution, but the distribution of intermediate energy ($1 < E < 15$ Mev) protons is markedly different. Using the measured fluxes of protons with $1 < E < 15$ Mev and E > 40 Mev, the parameters of the spectrum were determined assuming both power law and exponential forms. The parameters are presented as a function of L, and in the case of the exponential form the parameter E_0 can be represented by $E_0 = 47L^{-0.2}$. (auth)

27338 TRAPPED PROTONS IN THE SOUTH ATLANTIC MAGNETIC ANOMALY, JULY THROUGH DECEMBER 1961. 3. MAGNETIC STORMS AND SOLAR PROTON EVENTS. A. J. Zmuda, G. F. Pieper, and C. O. Bostrom (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 70: 2045-56(May 1, 1965).

With Injun 1 data for the inner Van Allen zone in the South Atlantic anomaly, it is shown that trapped protons with 1 Mev < E < 15 Mev and E > 40 Mev were not affected by the solar proton events and magnetic storms of July–December 1961. In the area near São José dos Campos, Brazil, for July 14–28, a period of intense and sustained activity with four solar proton events and six magnetic storms, the gross characteristics of the proton fluxes were similar to those for the surrounding quiet periods of July 1–12 and August 2–28: for protons >40 Mev the deviation from the local mean of the total period averages ±19%; for the 1- to 15-Mev protons, ±29%. For the region near Salisbury, Southern Rhodesia, the data were examined for intervals within the August–December period, which contained one major and four minor solar-

proton events and eleven storms. Here, in their gross characteristics, protons >40 Mev had an average stability of ±30% and 1- to 15-Mev protons, ±31%. In a detailed examination for protons >40 Mev, a stability to within an average of ±7% was found to exist at seventeen points in B-L space, each point being sampled more than once by the satellite during the July–December period. In addition, these (high-energy) particles had an unchanging flux in the slot ($2.1 < L < 2.5$) marking for these protons the outer boundary of the inner Van Allen zone, a region where the intensities are consistently low and, hence, where changes can be readily detected. The study of the inner zone behavior during the solar proton magnetic storm event of September 28 to October 4 yields results at least suggestive of an unchanging inner zone character during the event itself. (auth)

27339 MEASUREMENT OF ALBEDO NEUTRON LATITUDE VARIATION FROM A POLAR ORBITING SATELLITE. Joseph P. Martin (Martin Co., Baltimore). J. Geophys. Res., 70: 2057-63(May 1, 1965).

A neutron density measuring system was orbited on a polar satellite in September 1962 and recorded neutron counting rates for two days. The shape of the latitude variation of the measured neutron density was consistent with the shape predicted by Lingenfelter, but the absolute values were about a factor of 3 higher than the predicted densities. The latitude variation amounted to a factor of 10:1 between the poles and the equator. The results were sorted both into L intervals and into Quenby and Wenk rigidity intervals. It is seen that the L distribution is a much smoother variation than the rigidity distribution. The results of the experiment give an upper limit to the neutron density equal to $(1.1 \pm 0.2) \times 10^{-9}$ neutrons/cm^3 at the poles. It is not clear how much of this measured density is contributed by local production. (auth)

27340 MORPHOLOGY OF THE OUTER ZONE ELECTRON DISTRIBUTION AT LOW ALTITUDES FROM JANUARY THROUGH JULY AND SEPTEMBER 1963 FROM INJUN 3. T. Armstrong (Univ. of Iowa, Iowa City). J. Geophys. Res., 70: 2077-2110(May 1, 1965).

An intensive study was made of data from three 213 Geiger-Mueller (GM) tubes and one 302 GM tube that were carried on Injun 3. Median-latitude profiles of the electron population of the low-altitude region of the outer zone for energies $E_e \gtrsim 40$ kev, $E_e \gtrsim 230$ kev, and $E_e \gtrsim 1.6$ Mev were derived. Notable features of the median profiles are: the large diurnal variation for $L \gtrsim 7.5$ for trapped and precipitated 40-kev electrons; the lack of a sharply pronounced "slot" for 40-kev electrons and the consequent softening of the integral electron spectrum around $L = 3.0$; an apparent small diurnal variation of 230-kev trapped electrons for $6 \leq L \lesssim 8$; and a temporal change of about one order of magnitude in the intensity profile of 1.6-Mev electrons, which preceded and was followed by periods of relatively stable intensity for $2 \leq L \lesssim 4.5$. This change occurred during a $K_p = 7$ magnetic storm that began on June 6, 1963. The dependence of intensity on |B| was investigated with the following results. For specified L values in the range $2 \leq L \lesssim 7.5$ there is an apparent decrease in intensity of 40- and 230-kev electrons of about two to three orders of magnitude for |B| going from ~0.2 to ~0.5 gauss. The intensity of 1.6-Mev electrons also decreases about two orders of magnitude with |B| going from ~0.2 to ~0.5 gauss, and for $2 \leq L \lesssim 4.5$ the decrease in intensity due to the magnetic storm on June 6 is clearly evident. (auth)

27341 DIRECT MEASUREMENT OF AURORAL ELECTRONS OF LOW ENERGIES. R. D. Sharp, J. B. Reagan, S. R. Salisbury, and L. F. Smith (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Geophys. Res., 70: 2119-27(May 1, 1965).

The flux of precipitating electrons in the northern auroral zone was measured with scintillation-type detectors aboard a polar orbiting satellite. The total precipitated energy and spectra of electrons with energies greater than 180 ev were observed on each of 6 traversals of the auroral zone over distances of hundreds of kilometers. In most instances, the dominant contribution to the precipitated flux was from electrons with energies of less than 10 kev. Spectral measurements were made 128 times per second (every 63 meters), and rapid fluctuations in both total precipitated energy and spectral shape were observed. (auth)

27342 ENERGY SPECTRUM OF ELECTRONS AT LOW ALTITUDES. W. L. Imhof and R. V. Smith (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Geophys. Res., 70: 2129-34(May 1, 1965).

Electron energy spectrum measurements were made in October and November 1963, from a polar orbiting satellite with an apogee of 355 km and a perigee of 288 km. Data were taken with a plastic scintillation spectrometer equipped with a 16-channel pulse height analyzer operating in two energy ranges—0.3 to 2.6 Mev and 0.3 to 10.0 Mev. The data were all taken at B, L points whose traces have minimum altitudes of 200 to 355 km. In the Starfish region ($L \sim 1.3$), the spectrum was fissionlike at energies above ~2 Mev and rather flat below this energy, whereas on higher L shells the spectrum was considerably softer. The spectral shapes were fitted to the exponential form $d\phi/dE = Ae^{-\mu E}$, with a different value of μ for each of three different energy intervals (0.28 to 0.88 Mev, 0.88 to 2.08 Mev, and 2.08 to 4.88 Mev). The energy spectrum, suring the period after the sudden commencement of October 29, 1963, underwent significant temporal changes for $L \gtrsim 3$, but always displayed a general softening with increasing L value, except for hardening at $L \approx 3-5$ corresponding to the outer belt. (auth)

27343 BALLOON OBSERVATIONS ON THE RELATIONSHIP OF ENERGETIC ELECTRONS TO VISUAL AURORA AND AURORAL ABSORPTION. J. R. Barcus (Univ. of California, Berkeley). J. Geophys. Res., 70: 2135-47 (May 1, 1965).

Simultaneous bremsstrahlung x-ray and photometric measurements show a rather loose correlation, in the sense of a detailed space-time association, between the appearance of x rays at balloon altitudes and visual aurora at large L values. The observations suggest that essentially different, though not infrequently coupled, mechanisms are responsible for the low- and high-energy portions of the precipitated electron spectrum. Detailed examination of an ionospheric absorption event associated with auroral breakup indicates that the event is largely accounted for by the same flux of low-energy electrons responsible for the simultaneous luminosity enhancement. (auth)

27344 CONSERVATION OF THE FIRST AND SECOND ADIABATIC INVARIANTS. Richard L. Kaufmann (Univ. of New Hampshire, Durham). J. Geophys. Res., 70: 2181-6 (May 1, 1965).

Changes expected in the energy and equatorial pitch angles of geomagnetically trapped particles are calculated, assuming that the first and second adiabatic invariants are conserved and that the third invariant is violated. Figures are presented which permit comparisons to be made between theory and experimental measurements, and one such sample calculation is presented. Such calculations should provide a means of separating changes in the energy and mirror-point distribution produced by violation of the third invariant from changes produced by other mechanisms. (auth)

27345 GENERAL VLF PHASE VARIATIONS OBSERVED AT COLLEGE, ALASKA. H. F. Bates and P. R. Albee (Univ. of Alaska, College). J. Geophys. Res., 70: 2187-2208(May 1, 1965).

One of the original objectives of the v-l-f program at College was to determine how geomagnetic and auroral disturbances affected long-distance high-latitude v-l-f propagation. Phase and amplitude recordings of v-l-f signals at College, obtained primarily during 1963 from several of the stabilized v-l-f transmitters, were used in this study. Using both case-by-case and statistical correlation studies, no strong connection between geomagnetic or auroral disturbances and the large, frequent, short-term v-l-f phase variations observed at College was found. A consideration of the physical processes involved in the

production of geomagnetic disturbances shows that, in general, little or no direct effect on long-distance v-l-f signals would be expected. Auroral precipitations producing negative-bay disturbances are generally relatively limited in extent. Thus, an aurora could affect only those signals which pass near the precipitation region. An examination of the v-l-f records indicates that the second mode is not negligible at great distances during the night. The nighttime second mode amplitude may almost equal that of the first on 4000- to 5000-km paths. A strong second mode at the sunrise line seems necessary to produce the sunrise effect. For example, by using the sunrise fading pattern on v-l-f signals, it is shown that the second guided-wave mode propagated strongly to 7500 km at night on NBA-Europe paths during June 1962. This result is used to show that mode interference is important when considering v-l-f signal variations. A model involving the production of a disturbance wave by the conversion of energy from the primary field in relatively limited areas of the D region is proposed to explain the commonly observed 30 to 90° nighttime phase anomalies recorded at College. Suggested mechanisms for the production of the disturbance wave are mode conversion or diffraction from steep horizontal gradients in the D region. The propagation of the second mode to great distances poses a serious difficulty to the use of v-l-f data for D-region research. Second-mode interference effects in the 4000- to 5000-km range can lead to errors in computed effective reflection height changes of 30%; interpretations based on such computations would be quite misleading if the erroneous values were interpreted as actual heights or height changes in the D region. (auth)

27346 OPTICAL RADAR RESULTS AND IONOSPHERIC SPORADIC E. Giorgio Fiocco (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 70: 2213-15(May 1, 1965).

Correlations between optical radar echoes at heights between 110 and 140 km and ionospheric sporadic E are reported and interpreted as further evidence that the optical echoes were caused by incoming extraterrestrial particles and that E_s may at times be related to the same cause. (auth)

27347 GEOMAGNETIC AND SOLAR DATA. J. Virginia Lincoln, ed. (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 70: 2233-9(May 1, 1965).

Data on geomagnetic activity in 1964 (particularly for Oct., Nov., and Dec.) are presented, together with sunspot numbers for Dec. 1964. Information on solar-flare effects, sudden impulses, and sudden commencements is included for the second quarter of 1964, as are sunspot numbers and daily geomagnetic character figures for the last three years. (D.C.W.)

27348 ON DETERMINATION OF THE LOCATION OF THE EARTH'S MAGNETOSPHERE BOUNDARY AND COLLISIONLESS SHOCK WAVE. Vernon J. Rossow (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res., 70: 2245-8(May 1, 1965).

The possible sources of the scatter in the experimental data on the two boundaries are discussed, and it is determined that measurement of the electron velocity provides the best means for establishing the locations of the boundaries. (D.C.W.)

27349 EFFECT OF THE GEOMAGNETIC FIELD ON AN IONOSPHERIC SOUNDING PROBE. Toshihiko Dote, Hiroshi Amemiya, and Torao Ichimiya (Inst. of Physical Research, Tokyo). J. Geophys. Res., 70: 2258-61 (May 1, 1965).

The effect of the geomagnetic field on the saturation electron current and positive ion saturation current of an electrostatic probe is investigated. (D.C.W.)

27350 A QUALITATIVE MODEL OF GEOMAGNETIC STORM WITH SUDDEN COMMENCEMENT. Chuan-sin Liu and Hsiao-pin Tseng. Ti Ch'iu Wu Li Hsueh Pao, 13: 249-59(Dec. 1964). (In Chinese)

The process of the geomagnetic storm is studied by using the following qualitative model. The solar flare being taken as an explosion, the resulting corpuscular stream will propagate through the planetary space in the form of a shock wave and will penetrate into the magnetosphere through the neutral points. The ring current thus formed by the solar wind in the equator plane is responsible for the main phase of geomagnetic storm. By charge exchange of the protons with the neutral hydrogen atoms in the outersphere, the total energy of the penetrated particles gradually decreases when the storm is in its recovery period. According to different travel times of the shock wave, the storm-time magnetic variations on the earth surface are estimated, which coincide with the observed facts. (tr-auth)

27351 AN ELECTROMAGNETIC MODEL OF THE REVERSAL OF THE GEOMAGNETIC FIELD. Chi-chiang Chen and Kuei-chung Chi. Ti Ch'iu Wu Li Hsueh Pao, 13: 273-85(Dec. 1964). (In Chinese)

An electromagnetic model of the reversal of the geomagnetic field, based on Bullard-Parker's dynamo theory of the origin of the main geomagnetic field is described. It is shown that a reversal of the geomagnetic field may arise in the case in which the toroidal field in the earth's interior turns itself into the opposite direction. It is also shown that if a large enough "sudden fluctuation" is given to the earth's rotation by whatever means, then the electromagnetic interaction between the core and the mantle may give rise to a reversal of the toroidal field and consequently a reversal of the geomagnetic field. The calculation indicates that the "sudden fluctuation," which should be a decrease of the period of the Earth's rotation, is large enough only when its order of magnitude is greater than 10^2 msec. The time interval of each reversal is discussed. It is shown that each reversal can last 10^3 to 10^6 years. (tr-auth)

27352 THE INTERPRETATION OF MAGNETIC ANOMALIES ΔT. Chung-ch'u Hou. Ti Ch'iu Wu Li Hsueh Pao, 13: 324-8(Dec. 1964). (In Chinese)

It is proved, for the two-dimensional case, that the general expression of total intensity ΔT has the same form as the vertical intensity Z. The anomaly curves ΔT can then be considered as Z. Therefore, by use of the Cauch-Riemann condition in the theory of functions of a complex variable, its so called "negative harmonic conjugate function" $\overline{\Delta T}$, which corresponds to the anomaly curves H, is calculated from anomaly curves ΔT. It is indicated that interpretation of the magnetic data may be facilitated by using $\overline{\Delta T}$, together with its original function ΔT. Two examples of application are given: the calculation of the magnetic moment and its inclination for two-dimensional bodies from ΔT and $\overline{\Delta T}$; and downward analytical continuation of ΔT by use of values of ΔT and $\overline{\Delta T}$ on the horizon of observation. (tr-auth)

27353 SCIENTIFIC FINDINGS FROM EXPLORER VI. Washington, D. C., National Aeronautics and Space Administration, 1965. 390p. $2.25(GPO). (NASA SP-54)

A compilation of the papers that have been prepared on the basis of data acquired from Explorer VI is presented. The papers deal with cosmic and trapped radiation, micrometeorites, geomagnetism, electromagnetic wave propagation in the ionosphere, and perturbations in the motion of the satellite. (D.C.W.)

27354 AURORAL PHENOMENA. EXPERIMENTS AND THEORY. Martin Walt, ed. First Lockheed Research Symposium on Space Science. Stanford, Calif., Stanford University Press, 1965. 174p. $6.50. (CONF-640105).

Separate abstracts were prepared for the ten papers included. (D.C.W.)

For abstracts of individual papers see: 27355, 27356, 27357, 27358, 27359, 27360, 27361, 27362, 27363, and 27364.

27355 MORPHOLOGY OF AURORAL DISPLAYS. C. T. Elvey (Univ. of Alaska, College). p.1-15 of "Auroral Phenomena." Stanford, Calif., Stanford University Press, 1965.

A review of auroral morphology is presented, covering polar-glow aurora, polar-cap aurora, high red arcs,

medium-high gray arcs, and polar aurora. Some auroral models are briefly discussed in connection with polar aurora. It is concluded that several types of auroral displays can be described independently of each other. 40 references. (D.C.W.)

27356 TELEVISION CINEMAPHOTOGRAPHY OF AURORAS. T. Neil Davis (Goddard Space Flight Center, Greenbelt, Md.). p.15-19 of "Auroral Phenomena." Stanford, Calif., Stanford University Press, 1965.

The use of the orthicon television tube to obtain photographs of auroras is briefly reviewed, with consideration of the resolution and sensitivity of the method, as well as preliminary results on internal structure and motion within auroral forms. (D.C.W.)

27357 OPTICAL MEASUREMENTS OF AURORAS. A. Vallance Jones (Univ. of Saskatchewan, Saskatoon). p.20-38 of "Auroral Phenomena." Stanford, Calif., Stanford University Press, 1965.

A review of spectral observations on auroras is presented. 46 references. (D.C.W.)

27358 INTERACTION OF ENERGETIC CHARGED PARTICLES WITH THE ATMOSPHERE. A. Dalgarno (Queen's Univ., Belfast). p.39-45 of "Auroral Phenomena." Stanford, Calif., Stanford University Press, 1965.

Some of the effects of reactions of high-energy charged particles in the atmosphere are reviewed, with emphasis on the interpretation of auroral luminosity in terms of the excitation mechanisms. (D.C.W.)

27359 BALLOON MEASUREMENTS OF X-RAYS IN THE AURORAL ZONE. Kinsey A. Anderson (Univ. of California, Berkeley). p.46-83 of "Auroral Phenomena." Stanford, Calif., Stanford University Press, 1965.

A review of balloon measurements of x radiation in the auroral zone is presented, covering the properties of the x-ray fluxes and the parent electron spectrum. The intensity, energy, spatial distribution, and temporal structure of the electron flux, primarily, are considered. (D.C.W.)

27360 PRECIPITATION OF ENERGETIC PARTICLES INTO THE ATMOSPHERE. B. J. O'Brien (Rice Univ., Houston, Tex.). p.84-98 of "Auroral Phenomena." Stanford, Calif., Stanford University Press, 1965.

A review of satellite observations on electron precipitation into the atmosphere and its relation to auroras is presented, with consideration of the dependence of the electron flux on the pitch angle, magnetic-shell number, energy, and time. (D.C.W.)

27361 ELECTROMAGNETIC MEASUREMENTS OF AURORAS. R. L. Leadabrand (Stanford Research Inst., Menlo Park, Calif.). p.99-129 of "Auroral Phenomena." Stanford, Calif., Stanford University Press, 1965.

A review of radio observations on auroras is presented, with emphasis on studies using radar reflection from auroras. Some theories for auroral reflection are also briefly considered. 70 references. (D.C.W.)

27362 COORDINATED MEASUREMENTS ON AURORAS. J. E. Evans (Lockheed Missiles and Space Co., [Sunnyvale, Calif.]). p.130-49 of "Auroral Phenomena." Stanford, Calif., Stanford University Press, 1965.

The experimental methods and instrumentation used to obtain simultaneous measurements of the bombarding particle fluxes and the resulting optical luminosity and ionospheric electron density are described. Preliminary results are included. (D.C.W.)

27363 THE PRESENT STATUS OF AURORAL THEORY. Joseph W. Chamberlain. p.150-8 of "Auroral Phenomena." Stanford, Calif., Stanford University Press, 1965.

The status of the theory of auroral particles and bombardment is summarized. 47 references. (D.C.W.)

27364 SUMMARY OF AURORAL SYMPOSIUM. Anders Omholt (Univ. of Oslo). p.159-70 of "Auroral Phenomena." Stanford, Calif., Stanford University Press, 1965.

The information presently available on auroras is summarized, and areas are indicated in which further research may be useful. (D.C.W.)

Low Temperature Physics

Refer also to abstracts 26791, 26983, 27012, and 27205.

27365 (AD-611439) THERMAL CONDUCTIVITY OF SUPERCONDUCTING LEAD. James Wing Fai Woo (Cornell Univ., Ithaca, N. Y.). Feb. 1965. Contract Nonr 401(38). 13p. (TR-1). $1.00(CFSTI).

The anomalous thermal conductivity of superconducting Pb is discussed. A calculation of the thermal conductivity of normal and superconducting Pb was carried out using the theory of Ambegaokar and Tewordt, and the results agree with experiment. The large slope of the reduced conductivity is attributed in part to the large ratio $2\Delta(0)kT_c$, in part to the rapid decrease with frequency of the quasi particle lifetime, and in part to the large value of the logarithmic derivative of the T_n/T_s ratio. (D.L.C.)

27366 (IPP-4/13) SOME ASPECTS OF SUPERCONDUCTING MAGNETIC ENERGY STORAGE. B. Oswald (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1964. (CONF-640604-1). Dep.(mn).

From 3rd Symposium on Engineering Problems in Thermonuclear Research, Munich.

The energy density with and without iron is calculated. Completely closed coil systems are considered, and the effects of coil construction on the energy density are calculated. Estimated costs of one Joule are plotted vs storage energy. It is shown that inductive storage systems would be commercially feasible beyond 100 kJ. The discharge characteristics of magnetically stored energy are described. (D.L.C.)

27367 (ISS-64/29) SULLA STRUTTURA MATEMATICA DELLA TEORIA DI BARDEEN, COOPER E SCHRIEFFER. (On the Structure of the Theory of Bardeen, Cooper, and Schrieffer). G. Fano (Istituto Superiore di Sanita', Rome (Italy). Laboratori di Fisica). July 13, 1964. 19p. Dep.(mn).

Notes are presented of a seminar held at the Physics Laboratory of the Istituto Superiore di Sanita. The results of Haag's researches on the model of B. C. S. in the asymptotic limit of infinite volume are exhibited, and some details of formal character are clarified. (auth)

27368 (LNF-64/48) DEPENDENCE OF IONIC MOBILITIES IN LIQUID He^3 ON TEMPERATURE AND DENSITY. Note No. 259. P. de Magistris, I. Modena, and F. Scaramuzzi (Laboratori Nazionali Frascati, Comitato Nazionale per l'Energia Nucleare (Italy)). Oct. 9, 1964. 5p. (CONF-651-42). Dep.(mn).

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The mobilities of the anions and cations in liquid ^{3}He were measured as a function of the temperature and density of the liquid. (W.L.G.)

27369 (LNF-64/49) CHANGE OF THE MOBILITY OF POSITIVE IONS IN ROTATING HELIUM II. Note No. 260. I. Modena, A. Savoia, and F. Scaramuzzi (Laboratori Nazionali Frascati, Comitato Nazionale per l'Energia Nucleare (Italy)). Oct. 9, 1964. 9p. (CONF-651-41). Dep.(mn).

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

A device, consisting of two concentric cylindrical electrodes with an alpha-emitter plated on the inside surface of the outer electrode, was used to study the change of mobility of positive ions in rotating helium II. The current between the electrodes was measured as a function of the applied voltage. The relation that the current is equal to the product of a geometrical constant, the mobility, and the square of the applied potential was used to determine the mobility. Previous results showed a linear relation exists in the absence of rotation and a nonlinear relation in the presence of rotation for both positive and negative ions. Measurements of the change of mobility due to rotation for positive ions as a function of the angular velocity, the tem-

perature, and size of electrodes were made. Within the precisions of the measurements, no dependence could be found on the temperature or size of electrodes. The results are compared with those previously measured for negative ions, and some explanations for the observed behavior are advanced. (W.L.G.)

27370 (NP-14995) STABLE SUPERCONDUCTING COILS. Research Report 210. Z. J. J. Stekly and J. L. Zar (Avco-Everett Research Lab., Everett, Mass.). Mar. 1965. 17p.

A description is given of the principles of stabilizing a superconductor and the principles of a stable superconducting coil operation. A coil of this type not only operates on the short sample characteristic but also does not exhibit the uncontrolled transition to the normal state characteristic of conventional superconducting coils. Two main problems have plagued the field of superconducting coils in the past, namely the fact that current carrying capacity in a coil is in general not predictable and is considerably reduced from the current carrying capacity on short samples and the transition to the normal state is uncontrollable when the maximum current is reached, resulting in loss of the magnetic field. In contrast, the stabilized coil has a gradual rise of resistance as the critical current is exceeded. As the current is reduced again, the coil becomes completely superconducting at the same current value that resistance first appeared (at the short sample characteristic). The coil performance is reviewed with respect to the measured short sample characteristics. The achievement of the performance now removes any limitations on size or magnetic field of superconducting coils except those imposed by stress and the basic superconductor itself. (auth)

27371 LOW CRITICAL CURRENTS IN SUPERCONDUCTING NbC. John Piper (Union Carbide Research Inst., Tarrytown, N. Y.). Appl. Phys. Letters, 6: 183-4(May 1, 1965).

Superconductivity measurements were made on face-centered-cubic LrN, NbC, TaC, TiN and solid solutions of NbC–NbN and NbC–LrC, which were prepared by the powder metallurgy technique. Measurements of the variation of critical current with magnetic field are reported for two samples of NbC having a ratio of niobium to combined carbon of 0.985. The external-field dependence of the maximum magnetic flux trapped in a hollow cylinder of NbC was also measured to provide more sensitive determinations of the critical current. It is concluded from the results that the critical currents are several orders of magnitude lower for the face-centered-cubic hard metals than for the high-current superconductors. (L.B.S.)

27372 BEHAVIOR OF THE MAGNETIZATION OF HARD SUPERCONDUCTORS WITH TRANSPORT CURRENT IN TRANSVERSE FIELDS. [PART] I. M. A. R. Leblanc (Aerospace Corp., Los Angeles, Calif.), W. F. Druyvesteyn, and C. T. N. Chang. Appl. Phys., Letters, 6: 189-91 (May 1, 1965).

An extension of the Bean model applied to a transport current in a slab was used to show that the I–H paths as empirically grouped by LeBlanc lead to macroscopically identical magnetic states, and that simple analytical expressions describe the final magnetization states vs I/Ic for each group of I–H paths. (L.B.S.)

27373 NUCLEAR RELAXATION OF SOLID HELIUM-3 IN THE bcc PHASE. Robert C. Richardson, Earle Hunt, and Horst Meyer (Duke Univ., Durham, N. C.). Phys. Rev., 138: A1326-35(May 31, 1965).

Measurements of the nuclear transverse and longitudinal relaxation times T_2 and T_1 in solid helium-3 between 0.35 and 2°K are reported. Measurements over the whole density range in the bcc phase and for several frequencies between 0.3 and 8.2 Mc are presented. The value of the nuclear exchange parameter J is determined from the T_2 measurements using the theory of exchange narrowing first proposed by Anderson and Weiss. The parameter J is also obtained from the longitudinal relaxation time, which is equal to the relaxation time between Zeeman and the exchange bath over the temperature range where T_1 is temperature-independent. A third determination of J comes from the temperature-dependent T_1 below about 0.6°K, which is interpreted as the exchange lattice relaxation. The values of J from the three different methods are found to agree within experimental error for all the densities investigated. The results are compared with those of the IBM and Oxford workers. A study of the linewidth as a function of frequency shows the expected narrowing as the frequency is increased. (auth)

27374 ISOTHERMAL AND QUIESCENT He II FILM TRANSFER RATES OVER HEIGHTS TO 36 CM. R. W. Selden, J. H. Werntz, Jr., P. J. Fleming, and J. R. Dillinger (Univ. of Wisconsin, Madison). Phys. Rev., 138: A1363-70(May 31, 1965).

The volume rates of transfer of liquid He II through the film out of and into glass capillary beakers over heights up to 36 cm were measured. This was done at temperatures from 1.3 to 2.0°K under as nearly isothermal and quiescent conditions as possible. Results show that the volume rate of transfer R depends on the barrier height above the source liquid H and the gravitational pressure head ΔH. Unusual effects such as persistence of rates, jumps to other rates, and unstable behavior are discussed. The emptying and filling rates indicate that normalization of the flow to the smallest periphery above the source liquid is not sufficient. The dependence of R on ΔH is a function of temperature, the method of filling the beaker, the volume of liquid in the beaker, and the geometry of the reservoir supplying the film. (auth)

27375 EFFECTS OF DEVIATIONS FROM ISOTHERMAL AND QUIESCENT CONDITIONS ON THE He II FILM TRANSFER RATES. R. W. Selden and J. R. Dillinger (Univ. of Wisconsin, Madison). Phys. Rev., 138: A1371-7(May 31, 1965).

The effects of temperature differences between and mechanical agitation of the source and sink bulk liquids on the volume rates of transfer of liquid He II through the film into and out of a glass capillary beaker over heights to 31 cm were investigated. Temperature differences were produced by electric heaters, and mechanical agitation was produced by using a magnetic field modulated at a low frequency to cause a 1-mm diameter superconducting sphere to undergo translational oscillation. Values of heat flux up to 10^{-4}W/cm^2 produced only temperature differences which could be accounted for by distillation and thermomechanical effects. Such quantities of heat flux do not create sufficient turbulence to produce measurable effects on the transfer rates. Mechanical agitation of the source liquid increased the transfer rates, and agitation of the sink liquid decreased the rates. A minimum velocity of the sphere moving in the liquid was required to produce any measurable change ΔR in the transfer rates. After increasing with increasing velocity of the sphere, R was found to become independent of further increases in velocity. These results give further insight into the way in which transfer rates of liquid helium through the film depend on the state of turbulence of the bulk liquids which serve as the source and sink for the film. (auth)

27376 EFFECT OF ELECTRON MEAN FREE PATH ON THE CRITICAL TEMPERATURE OF SUPERCONDUCTORS. D. M. Ginsberg (Univ. of Illinois, Urbana). Phys. Rev., 138: A1409-11(May 31, 1965).

A simple calculation from first principles is made for the effect of electron mean free path on the phonon-induced electron-electron coupling in electronically isotopic superconductors. It is shown how the related shift in the critical temperature can be found. For tin alloys, this shift can be compared with that found previously by a different method, and the agreement is good, in spite of the simplicity of the model. (auth)

27377 HIGH-CURRENT SUPERCONDUCTIVITY? Daniel Hone (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 138: A1421-7(May 31, 1965).

The superconducting-gap equation was re-examined for samples of cross section smaller than the penetration depth in which current is flowing. The effects of retardation of the electron-phonon interaction have been included by means

of Green's-function techniques. The enhancement of the gap function due to Doppler shifting downward of the phonon frequencies, suggested by Parmenter five years ago, is again found. However, using the best current values for the metallic parameters involved, the magnitude of the effect is found to be too small to give the anticipated high-current, high-transition-temperature superconductors. It is estimated that electron-phonon coupling constants $N(O)V_0 \geq 0.77$ (almost double any observed in metals) and zero-current superconducting transition temperatures of the order of 50–100°K would be required to produce a stable high-current superconducting state. (auth)

27378 CRITICAL-FIELD STUDY OF SUPERCONDUCTING ALUMINUM. Sandor Caplan and Gerald Chanin (Univ. of Pittsburgh). Phys. Rev., 138: A1428-33(May 31, 1965).

The critical field of pure aluminum was measured down to 0.28°K. Because the measurement technique requires a magnetic field gradient, both normal and superconductive phases were present in the sample, thus avoiding superheating and supercooling effects. The movement of the phase boundary in response to a change in magnetic field was continuously observed, its position at equilibrium leading to a determination of the critical field. Hysteresis in the transition was 0.3% of the critical field, with reduction to arbitrarily small values apparently possible. The deviation curve shows the usual weak-coupling characteristics and, apart from a low-temperature anomaly attributed to uncertainties in the vapor-pressure thermometry, good agreement with BCS theory. The measurements yield $T_c = 1.175 \pm 0.001$°K and $(dH_c/dT)_{T_c} = 158 \pm 4$ Oe/°K, while analysis of the low-temperature data indicates $H_0 = 104.8 \pm 0.6$ Oe with γ in the range 1.23 to 1.30 mJ/mole(°K)^2. (auth)

27379 ATTENUATION OF LONGITUDINAL ULTRASOUND IN SUPERCONDUCTING LEAD. R. E. Love, R. W. Shaw, and W. A. Fate (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 138: A1453-60(May 31, 1965).

The ultrasonic pulse-echo technique was used to measure the absorption of ultrasound in superconducting and normal single-crystal lead. Longitudinal sound waves were propagated in the [100], [110], and [111] crystallographic directions at frequencies between 10 and 70 Mc. The purpose of this investigation was to measure the temperature dependence of the superconducting energy gap as well as to attempt to observe its anisotropy. Sufficiently reliable data at low temperatures to do the latter could not be obtained with the present apparatus. The temperature dependence could be reliably measured above a reduced temperature ($t = T/T_c$) of 0.5, and an average zero-temperature energy gap of $2\Delta(0) = (4.1 \pm 0.2)kT_c$ was obtained using the BCS temperature dependence for extrapolation. In the course of this investigation, the attenuation was found to be amplitude-dependent in the superconducting state, while at the same temperature in the normal state it was amplitude-independent. The energy gap quoted above was measured at the smallest possible amplitudes. The empirical nature of the amplitude effect and its consequences in the determination of the energy gap in lead are discussed. The possibility is pointed out that disagreements between energy-gap temperature dependences predicted by BCS theory and those derived from ultrasonic measurements in elements other than lead may be due to this effect. (auth)

27380 PRESSURE COEFFICIENT AND PHASE DIAGRAM OF He^4 NEAR THE UPPER LAMBDA POINT. Henry A. Kierstead (Argonne National Lab., Ill.). Phys. Rev., 138: A1594-9(June 14, 1965).

Measurements are reported of the derivatives $(dP/dT)_\lambda$, $(d\rho/dT)_\lambda$, and $(d\rho/dP)_\lambda$ on the lambda curve, of $(dP/dT)_m$ on the melting curve, and of the pressure coefficient $\beta_v = (\partial P/\partial T)_v$ of the liquid very close to the upper lambda point $(T_{\lambda'}, P_{\lambda'}, V_{\lambda'})$. The measurements are well represented by the equations $(dP/dT)_\lambda = -55.54 - 96(T_\lambda - T_{\lambda'})$, $T_\lambda - T_{\lambda'} \leq 12.5 \times 10^{-3}$°K; $(d\rho/dT)_\lambda = -43.7 - 230(T_\lambda - T_{\lambda'})$, $T_\lambda - T_{\lambda'} \leq 12.5 \times 10^{-3}$°K; $(d\rho/dP)_\lambda = 0.7868 + 2.8\,(T_\lambda - T_{\lambda'})$, $T_\lambda - T_{\lambda'} \leq 12.5 \times 10^{-3}$°K; $(dP/dT)_m = 29.43 + 326(T_m - T_{\lambda'})$, $0 \leq T_{\lambda'} - T_m < 17 \times 10^{-3}$°K; $(\partial P/\partial T)_v = 9.39 + 7.69 \log_{10}(T - T_\lambda)$, $V = V_\lambda$ 6×10^{-5}°K $\leq T - T_\lambda \leq 6 \times 10^{-3}$°K; where P is in atm, T is in °K, and ρ is in mg/cm^3. The temperature and pressure of the upper lambda point are $T_{\lambda'} = 1.7633 \pm 0.0001$°K, $P_{\lambda'} = 29.84 \pm 0.02$ atm. There is no evidence of a first-order transition in the solid in the temperature range -17×10^{-3}°K $< T - T_{\lambda'} < 4.3 \times 10^{-3}$°K. (auth)

27381 THERMODYNAMIC PROPERTIES OF MOLYBDENUM IN ITS SUPERCONDUCTING AND NORMAL STATE. David C. Rorer, David G. Onn, and Horst Meyer (Duke Univ., Durham, N. C.). Phys. Rev., 138: A1661-8(June 14, 1965).

Specific-heat measurements were carried out on four samples of molybdenum in the normal and superconducting states between 0.4 and 4°K. For one sample, a detailed investigation was also made of the specific heat, the latent heat, and the critical-field curve in the region of the normal transition point T_c and in fields up to 5 G. For a reversible transition, these quantities are related by thermodynamic equations and they were found to be consistent within experimental error. The transition temperatures in zero field were found to be 0.915, 0.917, 0.918, and 0.83°K, respectively. No lambda anomaly in the specific heat could be detected there. From the measurements between 0.4 and 0.9°K, the electronic specific heat in the superconducting state was derived and compared to that expected from the BCS theory. The deviations from the theory at the low-temperature end are thought to be due to anisotropy in the energy gap. The energy-gap parameter and the critical-field curve were also deduced and compared with results from acoustic measurements. (auth)

27382 POSSIBILITY OF PHONON-INDUCED SUPERCONDUCTIVITY. Paul H. E. Meijer (Universite, Paris). Phys. Rev. Letters, 14: 784-6(May 10, 1965).

The possibility of the creation of phonons with frequencies comparable to the Debye frequency for induced superconductivity is investigated on the basis of a mechanism introduced by Fröhlich. (L.B.S.)

27383 OBSERVATION OF THE HALL EFFECT IN SUPERCONDUCTORS. W. A. Reed, E. Fawcett, and Y. B. Kim (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 14: 790-2(May 10, 1965).

The observation of the Hall effect in superconducting niobium and indium is reported. Measurements were made of the transverse and resistive voltages by a standard d-c method for the niobium sample in magnetic fields up to 18 kG for three combinations of current density and temperature, and for the indium sample at 1.38°K with a current density of 600 amp/cm^2. The ratios of the Hall and resistive electric fields for each sample are shown, and the resistance in the intermediate state below the critical field H_c for indium is found to fall with decreasing H more rapidly than that of the niobium sample. (L.B.S.)

27384 FREE PATHS IN SUPERCONDUCTING STATES, IN NORMAL STATES, AND IN INTERMEDIATE STATES. Peter Wyder (Eidgenossische Technische Hochschule, Zurich). Physik Kondensierten Materie, 3: 292-304(1965). (In German)

By size-effect measurements of the thermal conductivity of thin indium wires, the mean free path of the excitations was determined in the normal and in the superconducting state. Within the accuracy of these measurements, the mean free paths in the two states are found to be equal. For the intermediate state, the electron scattering from the interphase boundaries was investigated both experimentally and theoretically. The experimental results can be explained with the aid of the BCS theory of superconductivity. (auth)

Neutron Physics

See also REACTOR TECHNOLOGY — Criticality Studies.

Refer also to abstracts 25910 and 27538.

27385 (CEA-R-2774) CONTRIBUTION A L'ETUDE DE LA PROPAGATION DES NEUTRONS DANS DES

CAVITES. (Contribution to the Study of Neutron Propagation in Cavities). Gilbert Hasselin (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre de Etudes Nucleaires). Mar. 1965. 132p. Dep.(mn).

In large size cavities where the dimensions of the holes are greater than the mean free path of the radiations, neutron propagation calculations are carried out by taking into account the effect of the medium surrounding the hole using a reflection coefficient or albedo. The fast neutron albedos are obtained for various materials, and these results are applied for a Monte-Carlo propagation calculation. A comparison of this calculation with experimental results shows the validity of the method. (auth)

27386 (GA-5750) MEASUREMENT OF NEUTRON SPECTRA IN LIQUID HYDROGEN. Final Report. G. D. Trimble, G. K. Houghton, and J. H. Audas (General Atomic, San Diego, Calif.). Sept. 30, 1964. Contract NAS-3-4214. 243p. (NASA-CR-54230; N65-19701). $6.00(CFSTI).

Differential fast neutron spectra are presented for the neutron energy range 0.5 to 15 Mev in both water and liquid hydrogen as a function of space and angle. Measurements were made for 13.0, 10.5, 7.0, 4.5, and 2.5 inches of liquid hydrogen, at angles of 0, 15, 37, 53, and 78°; water measurements were made for 1.5 and 6.4 inches at the same angles. A description of the liquid hydrogen experimental facility is given, including design considerations. Also included is a discussion of the development of the isotropic fast neutron source and differential neutron spectra taken with this source. (auth)

27387 (GA-6290) MEASUREMENTS AND CALCULATIONS OF THE SLOWING DOWN AND MIGRATION TIME. A. E. Profio, J. U. Koppel, and A. Adamantiades (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). Apr. 5, 1965. Contract AT(04-3)-167. 22p. (CONF-650504-12). Dep.(mn); $1.00(cy), 1 (mn) CFSTI.

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

A review is presented of calculations of neutron slowing down and spatial migration. Space-independent theory and space-dependent theory are discussed, and theoretical results are compared with experimental results. (D.L.C.)

27388 (GA-6291) NEUTRON SPECTRA IN H_2O, D_2O, BeO, AND CH_2. J. M. Neill, J. C. Young, G. D. Trimble, and J. R. Beyster (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). Apr. 5. 1965. Contract AT(04-3)-167. 17p. (CONF-650504-13). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

Neutron spectral measurements were made in poisoned H_2O, D_2O, and BeO and in polyethylene. Pulsed neutron time-of-flight techniques were used in the measurements, which included position-dependent measurements. The results were compared with scattering models. (D.L.C.)

27389 (GA-6295) DIFFERENTIAL NEUTRON SCATTERING FROM HYDROGENEOUS MODERATORS. J. R. Beyster, J. C. Young, J. M. Neill, and W. R. Mowry (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). Mar. 6, 1965. Contract AT(04-3)-167. 20p. (CONF-650504-14). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

Absolute measurements of the single differential scattering cross sections $d\sigma/d\Omega$ were made for thermal neutrons in H_2O, D_2O, and $ZrH_{1.85}$ at various neutron energies. The results are compared with theoretical calculations. (D.L.C.)

27390 (GA-6313) NEUTRON SPECTRA IN BULK MEDIA BY TIME-OF-FLIGHT. J. L. Russell, Jr., J. R. Beyster, J. R. Brown, K. L. Crosbie, G. K. Houghton, A. E. Profio, and G. D. Trimble (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). Apr. 9, 1965. Contract AT(04-3)-167. 22p. (CONF-650504-11). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

After a description of the experimental equipment, measurements of neutron spectra at various angles are reported for paraffin wax, liquid hydrogen, lead, and graphite. The measurements are compared with calculated spectra. (D.L.C.)

27391 (GEAP-4846) TRANSPORT EQUIVALENT DIFFUSION THEORY. Quarterly Progress Report No. 4, January 1–March 31, 1965. G. H. Kear (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 14p. (EURAEC-1388). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A new method for solving the multigroup diffusion equation is discussed. The solution is obtained from a series type solution with successive operations of the buckling matrix upon itself as coefficients of the scalar spatial terms. (auth)

27392 (INR-573/IXA) PULSED NEUTRON SOURCE. S. Chwaszczewski and K. Dybowski (Institute of Nuclear Research, Warsaw (Poland)). Nov. 1964. 14p. Dep.

A description is given of a pulsed neutron generator, based on the (DT) reaction. An instrumentation of the above generator is prepared permitting one to measure physical parameters of moderating and multiplying media. The neutron efficiency of the generator was measured, and calibrating measurements of neutron decay constants in light water were made. Recently, this neutron generator (IGN-200) was equipped with a 2-m long target tube permitting investigation of the ANNA critical assembly. (auth)

27393 (KAPL-M-6143) KRUDE — RESONANCE ABSORPTION PROGRAM. K. R. Edgar (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 1964. Contract W-31-109-eng-52. 47p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

The KRUDE computer program gives a numerical solution of the neutron slowing down equation for a mixture of resonance and non-resonance isotopes in an infinite homogeneous medium. An asymptotic flux (1/E) is assumed above the resonance energy region. Zero temperature resonance cross sections are calculated by the Breit-Wigner formula. The temperature broadened resonance and interference line shapes are obtained by numerical solution of their differential equations given by Amster. Precalculated cross sections may be used also. The output of the program includes pointwise flux, collision density, scattering rate, absorption rate, cross sections, and isotopic absorptions. These items may be plotted on the CALCØMP plotter. (auth)

27394 (KAPL-M-6420) ETC4A — A ONE DIMENSIONAL MONOENERGETIC TRANSPORT PROGRAM (REVISION II). E. J. Brooks, Jr., C. W. Dawson, and T. E. Dudley (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 4, 1964. Contract W-31-109-eng-52. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The program ETC4A, for the Philco 2000, solves the monoenergetic transport equation in slab geometry. Quantities which may be determined are the point by point scalar flux, the scalar flux averaged over regions, angular components of the flux, and currents. Solutions up to the order of a double P_{16} (or full range P_{32}) approximation can be obtained. Sources and neutron scattering are described by either a P_0 or P_1 expansion. A maximum number of 176 spatial mesh points is available for calculations of detailed behavior of the neutron flux. This revision contains a corrected version of the original report and a description of additional options requested for the program. These options are for self-shielding calculations. (auth)

27395 (ORNL-RSIC-3) A COMPARISON OF FIRST- AND LAST-FLIGHT EXPECTATION VALUES USED IN A 05R MONTE CARLO CALCULATION OF NEUTRON DIS-

TRIBUTIONS IN WATER. D. K. Trubey and M. B. Emmett (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 25p. Dep.; Free (ORNL).

The distributions in water of fast neutrons from isotropic fission and 14-Mev point sources were calculated with the 05R Code. Two methods of scoring the same case histories were used to estimate the energy distribution and the dose rate. The estimators employed were the "first-" and "last-"flight expectation, or statistical estimation, values. The first-flight estimator was found to be somewhat better due to the importance of the first flight in the total transport of the neutrons. The results are in good agreement with Renupak moments method results and with experimental results. (auth)

27396 (RRA-T47) A MONTE CARLO STUDY OF NEUTRON TRANSPORT THROUGH ALUMINUM, POLYETHYLENE, AND CARBON SLABS. M. B. Wells (Radiation Research Associates, Inc., Fort Worth, Tex.). Dec. 30, 1964. Contract NAS 8-11047. 147p.

Monte Carlo methods were used to perform a parameter study of the transport of fast neutrons through slabs of aluminum, polyethylene, and carbon. The calculations were performed to provide data to be used in machine calculations of the neutron dose rate in space vehicles which results from proton-induced nuclear evaporation. Plane-isotropic-monoenergetic neutron sources were used in the calculations. The source plane locations and source energies were selected so that data for slabs to 30 cm in thickness and source energies between 0.5 and 14 Mev could be obtained by interpolation from the Monte Carlo calculations. Infinite media data for plane sources in the same three materials were obtained from additional Monte Carlo calculations of the spatial distribution of the dose rate from point-isotropic-monoenergetic neutron sources in these infinite media. A comparison of the results of the slab and infinite medium calculations shows that there are significant boundary effects on the fast-neutron dose rates transmitted through aluminum and carbon slabs. Although the magnitude of the boundary effect depends on the source material, plane location, and slab thickness, large differences are noted between the transmitted dose rates for slabs and for infinite media. (auth)

27397 (WANL-TNR-133) VARI-QUIR—A TWO-DIMENSIONAL TIME-DEPENDENT MULTI-GROUP DIFFUSION CODE. J. W. Riese and G. Collier (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Sept. 1963. 93p.

A variational approximation is developed to solve the time-dependent neutron diffusion equations. The method is incorporated into a computer code, which allows up to 4 energy groups and 6 precursors. Some sample results are presented. (auth)

27398 STATISTICAL-MECHANICAL THEORY OF INCOHERENT VAN HOVE'S SCATTERING FUNCTION FOR THERMODYNAMIC SYSTEMS. Andrzej Fulinski (Jagellonian Univ., Krakow). Acta Phys. Polon., 27: 245-58 (Feb. 1965).

Using the so-called second quantization formalism, the incoherent scattering function $S_{inc}(Q,\omega)$ is found to be related (in some energy range) in a simple way with the average occupation numbers $\langle N(p)\rangle$ (being Maxwell-Boltzmann, Fermi-Dirac, or Bose-Einstein distributions for non-ideal systems of interacting particles). This gives the possibility of determination of $\langle N(p)\rangle$ from incoherent scattering experiment, especially, from slow neutron scattering by thermodynamic systems, and, on the other hand, permits to calculate the scattering function using e.g., the (temperature-dependent) perturbation theory. It is found, among others, that the coherent part of scattering tends towards zero for ideal Boltzmann systems. It is, however, no longer valid for ideal quantum systems. The perturbation corrections are given for Boltzmann systems and it is found that the interaction between the particles of the scattering system can cause the decrease of the cross section. The perturbational corrections depend on the proper form of the potential of interaction between particles of the scatterer. (auth)

27399 COOLING OF NEUTRONS BY CAPTURE. F. Verdaguer (Junta de Energia Nuclear, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 40: 135-40 (July-Aug. 1964). (In Spanish)

The effect of non-$1/v$ capture on the diffusion parameters of light water was studied theoretically. A volume-cooling effect appears, which depends on the mean-square energy transfer (M_2) in the same manner as does the normal surface-cooling effect. This provides an independent method for measuring M_2. (D.C.W.)

27400 MEASUREMENT OF THE TOTAL CROSS SECTION OF CARBON, FLUORINE, AND VANADIUM FOR NEUTRONS WITH ENERGY BETWEEN 2600 AND 2850 kev. Andre Sorriaux (CEN, Saclay). Compt. Rend., 260: 3045-8(Mar. 15, 1965). (In French)

The total cross sections of carbon, fluorine, and vanadium were determined by the associated particle method; this method has the advantage of eliminating the majority of parasitic phenomena. The neutrons were produced by the $D(d,n)^3He$ reaction. The experimental conditions are such that the energy resolution of the neutrons is 50 kev. (tr-auth)

27401 POLYETHYLENE FREQUENCY SPECTRUM FROM "WARM"-NEUTRON SCATTERING. W. Myers, J. L. Donovan, and J. S. King (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 42: 4299-4300(June 15, 1965).

Neutron scattering on highly crystalline polyethylene at 100°K and a 90° scattering angle was studied. Neutrons were downscattered from variable "warm" energies to a fixed final energy of 0.030 ev in a triple-axis crystal spectrometer. The data were converted to a phonon frequency spectrum according to the one-phonon incoherent scattering approximation, with the Debye-Waller factor set to 1. Data are presented in graphs. (M.C.G.)

27402 THERMAL NEUTRON SPECTRA NEAR ABSORBERS. C. B. Bigham (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Sci. Eng., 21: 106-13(Jan. 1965).

The perturbation in a thermal neutron spectrum near an absorber immersed in a moderator was studied using activation techniques. The results show two separate effects for pure thermal spectra, a 'transmission hardening' depending on the energy variation of the absorber cross section and a 'boundary effect' depending on the energy variation of the moderator scattering cross section. These results are in agreement with energy-dependent Milne problem calculations for a mass-one, free-gas moderator and with another experimental result when a third 'source hardening' effect in reactor spectra is considered. (auth)

27403 APPROACH TO EQUILIBRIUM OF A NEUTRON PULSE IN A MULTIPLYING SYSTEM. A. K. Ghatak and S. Pearlstein. Nucl. Sci. Eng., 22: 182-90(1965). (BNL-8438)

A numerical experiment of the transient neutron behavior following a source burst was performed. The time-dependent Boltzmann equation (in the diffusion approximation without delayed neutrons) was propagated in time until asymptotic conditions were reached. The explicit time, space, and energy solution was programed for the IBM-7094. Space-independent calculations of defined effective multiplication factors, neutron lifetimes and decay constants were performed for hydrogenous and graphite-moderated ^{235}U or ^{239}Pu systems. Seventy-three velocity groups were employed to detail spectral changes that occur in the approach to equilibrium. About 20 and 150 μsec, respectively, were required for the energy modes to decay in the hydrogenous and graphite systems considered. The initial response of a cadmium detector is shown to be similar in multiplying and nonmultiplying assemblies and indicates the neutron slowing-down time to the cadmium resonance. No further structure in the cadmium-detector response due to the regenerative process was noted. The space-dependent properties of bare and reflected one-dimensional slabs were also briefly studied. (auth)

27404 A SOLUTION OF THE SPACE-ENERGY-ANGLE-DEPENDENT NEUTRON SLOWING-DOWN PROBLEM. Joseph J. McInerney (Pennsylvania State Univ., University Park). Nucl. Sci. Eng., 22: 215-34(1965).

A general procedure for solving the space-energy-angle-dependent neutron transport equation is presented. A complete set of eigenfunctions of the transport equation is found under the assumptions of plane symmetry, constant cross sections, and stationary nuclei. The eigenfunctions are shown to be orthogonal with a proper weight function. The slowing-down problem in a hydrogen medium is treated in detail. An analytical solution of this problem is compared with the results of a Monte Carlo experiment. (auth)

27405 IMPROVED RATIONAL ESCAPE PROBABILITY IN LUMPED ABSORBERS. Charles N. Kelber (Argonne National Lab., Ill.). Nucl. Sci. Eng., 22: 244-7(1965).

It is possible to derive a correction to the mean chord length used in the Wigner Rational Approximation which gives a better estimate of the escape probability, preserves the equivalence relationship for each resonance, and preserves the value of the resonance-integral. It is shown that employing the last criterion dictates an averaging procedure similar to earlier ones but involving different weighting points. A table of weighting points is given. (auth)

27406 SOME INPUT FUNCTIONS FOR ANISOTROPIC NEUTRON SCATTERING. W. Maurice Pritchard (Old Dominion Coll., Norfolk, Va.) and Tino Ahrens. Nucl. Sci. Eng., 22: 248-52(1965).

Expressions have been derived for computing the effects of anisotropic neutron scattering in the center-of-mass system on the average cosine and the average cosine squared of the scattering angle in the laboratory system, the average logarithmic energy decrement per collision, and the average square of the logarithmic energy decrement per collision if the angular distribution of the neutron scattering cross section in the center-of-mass system in known. In a Legendre polynomial representation, the effect of scattering anisotropy is to require additive correction terms to the usual isotropic scattering approximations for these parameters. The magnitudes of the correction terms depend on the mass of the scattering atom and the degree of anisotropy exhibited by the scattering cross section in the center-of-mass system. (auth)

27407 A MORE STRAIGHTFORWARD USE OF VARIATIONAL PRINCIPLES WITH BOUNDARY CONDITIONS. Harvey Amster (Univ. of California, Berkeley). Nucl. Sci. Eng., 22: 254-9(1965).

A previous treatment (Nucl. Sci. Eng., 16: 147-54(1963)) of one-group diffusion theory for a homogeneous slab is reviewed for the special situation in which scattering is isotropic and no neutrons enter the medium outside its surfaces. (C.E.S.)

27408 THE TREATMENT OF BOUNDARY TERMS IN A VARIATIONAL PRINCIPLE CHARACTERIZING TRANSPORT THEORY. G. C. Pomraning (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 22: 259-61(1965).

A variational treatment (H. Amster, Nucl. Sci., Eng., 22: 255 (1965)) of the diffusion theory boundary conditions is considered. This treatment is purported to be more correct than a variational treatment by Pomraning and Clark (Nucl. Sci. Eng., 16: 147 (1963)). It is pointed out that the treatment of the diffusion theory (or higher order P_N) boundary conditions is, by necessity, arbitrary (even within the framework of the variational method) and that the two treatments are different in their aims. (C.E.S.)

27409 ANSWER TO POMRANING'S REBUTTAL ON VARIATIONAL BOUNDARY CONDITIONS. Harvey Amster (Univ. of California, Berkeley). Nucl. Sci. Eng., 22: 262 (1965).

Rebuttal to the arguments given in "The Treatment of Boundary Terms in a Variational Principle Characterizing Transport Theory" (Nucl. Sci. Eng., 22: 259 (1965)) is presented. (C.E.S.)

27410 P_1 ANALYTICAL SOLUTION OF THE ENERGY AND SPACE-DEPENDENT TRANSPORT EQUATION FOR THERMAL NEUTRONS. Nucl. Sci. Eng., 22: 263-5(1965).

The solution of the energy- and space-dependent transport equation for thermal neutrons was considered under the following conditions: homogeneous infinite medium of plane geometry, sources distributed symmetrically about the ($z = 0$) plane, P_1 approximation of the scattering kernel, and P_1 approximation of the solution. (C.E.S.)

27411 DETERMINATION OF THE SCATTERING LAWS OF SOME ORGANIC SUBSTANCES WITH SLOW NEUTRONS. W. Glaeser (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 7: 64-74(Feb. 1965). (In German)

With a double spectrometer for slow neutrons, consisting of a torsion crystal monochromator and an arrangement for simultaneous time-of-flight measurements, scattering experiments on benzene, biphenyl, and diphyl (73.5% diphenyl ether and 26.5% diphenyl) were carried out. With incident energies in the range from 0.019 to 0.08 ev, wave number and energy changes of 0 to 12 $Å^{-1}$ or 0 to 4.2 k_0T could be detected. From the measurement results, the "scattering law" of the substances investigated was calculated and, by application of a simple model over the experimental range, the pulse and energy alterations could be extrapolated. Frequency distributions generalized from the scattering law were derived, from which statements on the dynamic properties of the systems investigated could be made. (tr-auth)

27412 THEORETICAL METHODS AVAILABLE FOR CALCULATION OF FAST AND EPITHERMAL NEUTRON SPECTRA. K. Ott (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 7: 161-6(Mar. 1965).

A brief survey of the Monte Carlo and multi-group methods for calculating neutron spectra is given, with emphasis on the latter and with reference to specific computer programs. (D.C.W.)

27413 EIGENVALUES OF THE NEUTRON TRANSPORT EQUATION. J. Wood (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 85: 805-7(Apr. 1965).

Results are given of the eigenvalues obtained for the pulsed-neutron source and diffusion-length problems using the gas kernel. Three methods of solution are reported: the diffusion approximation, the spherical harmonic (P_3) approximation, and the B_0 approximation. (auth)

27414 REFLECTION AND TRANSMISSION IN A STRONGLY ABSORBING SLAB. André Mockel. Univ. Bruxelles, Inst. Phys., Bull. No. 14, 1-28(June 1964). (In French)

The problem of the total reflection and transmission of monoenergetic particles of known incident distribution in a slab of strongly absorbing matter was studied from the viewpoint of its numerical solution. Several approximation methods based on the known theoretical solutions of the problems are proposed. These are compared with the results obtained by numerical integration of the tables published by Bellman, Kalaba, and Prestrud. Another approximation of the same form as the P_1 approximation, but with adjusted coefficients is also proposed. This has the advantage of a very satisfactory precision for all the values of the parameters (the error is less than 2%) and a great simplicity of calculation. (tr-auth)

Nuclear Properties and Reactions

Refer also to abstracts 26684, 26698, 26935, 27117, and 27182.

27415 (AE-179) HINDERED E1 TRANSITIONS IN Eu^{155} AND Tb^{161}. Sven G. Malmskog (Aktiebolaget Atomenergi, Stockholm (Sweden)). Feb. 1965. 22p. Dep.(mn).

The absolute E1 transition probabilities from the $^3/_2$ + (411), $^5/_2$ − (532), and $^7/_2$ − (523) single particle levels in ^{155}Eu and ^{161}Tb were measured by the method of delayed coincidences. Half lives of $T_{½} < 0.2$ nsec and $T_{½} = (1.38 \pm 0.06)$ nsec for the 104.4 and 246 kev levels in ^{155}Eu and $T_{½} = (0.84 \pm 0.04)$ nsec and $T_{½} < 0.2$ nsec for the 417.6 and 480.6 kev levels in ^{161}Tb were found. The result is compared with the calculations of a single particle in a deformed potential carried out by Nilsson. (auth)

27416 (CONF-650425-1) MÖSSBAUER EFFECT STUDIES WITH ACTINIDES. J. A. Stone (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr. 7, 1965. Contract AT(07-2)-1. 34p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From Panel on the Uses of the Mössbauer Effect in Chemistry and Solid State Physics, Vienna.

The Mössbauer effect is expected to become a valuable tool for studying properties of the actinide elements. Numerous gamma transitions in actinide isotopes appear to be suitable for nuclear resonance absorption, and a compilation of these is given. The 59.6-kev gamma ray in ^{237}Np has been demonstrated to give the Mössbauer effect, following both beta- and alpha-decay; the current experimental and theoretical situation with this isotope is reviewed. A search is underway for narrow, single emission and absorption lines for use as probes of hyperfine structure. Future possibilities for work with ^{237}Np are discussed; nuclear moments of ^{237}Np, chemical bonding and magnetic properties of Np compounds, lattice dynamics, and radiation damage are some of the areas where new information may be obtained. (auth)

27417 (GA-5944) NEUTRON CROSS SECTIONS FOR U^{235}. G. D. Joanou and M. K. Drake (General Atomic, San Diego, Calif.). Dec. 10, 1964. Contract SNPC-27. 141p. (NASA-CR-54263; N65-16203). $4.00(CFSTI).

Experimental and analytical neutron cross sections for ^{235}U are tabulated. The data are incorporated into the GAM-II slowing-down program and the GATHER-II thermalization program. The neutron energy range studied is that from 1 Mev to 15 Mev. The results are also presented in graphical form. (T.F.H.)

27418 (HW-SA-3519) CALORIMETRIC DETERMINATION OF THE HALF LIFE OF ANTIMONY-124. D. M. Fleming and I. T. Myers (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). June 1, 1964. Contract AT(45-1)-1350. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Gamma-ray calorimetric measurements were made on an irradiated antimony specimen after the decay of ^{122}Sb and ^{125}Sb. The results gave a half life of 60.20 ± 0.03 days for ^{124}Sb, with a standard deviation of 0.012 days. (D.L.C.)

27419 (INR-601/VI/PH) EMISSION OF FAST DEUTERONS IN INTERACTIONS OF 24-Gev/c PROTONS WITH HEAVY NUCLEI IN EMULSION. Teresa Saniewska, Ewa Skrzypczak, and Przemyslaw Zielinski (Institute of Nuclear Research, Warsaw (Poland)). Jan. 1965. Dep. (mn).

In interactions of 24 Bev/c protons with heavy nuclei in emulsion, the frequency of emission and the angular and momentum distributions of fast deuterons in the momentum interval 400–900 Mev/c are investigated. A very copious emission of fast deuterons in large stars (1.8 ± 0.3) per star is observed. The experimental results are discussed from the point of view of the model presented by Butler and Pearson. (auth)

27420 (IS-1086) PHOTONEUTRON CROSS SECTIONS OF Pr^{141}, O^{16}, AND C^{12}. John N. Bradford and Barnett C. Cook (Ames Lab., Iowa State Univ. of Science and Tech.) Feb. 1965. Contract W-7405-eng-82. 114p. Dep.; $4.00 (cy), 3(mn) CFSTI.

Cross sections for the (γ,n) reaction were determined from threshold to 65 Mev. Structure appears throughout most of the energy range in the ^{16}O and ^{12}C cross sections. The giant resonance is clearly split into several components in both cases. The ^{141}Pr cross section shows no resolved structure. Comparison is made with the predictions of the particle-hole model. Experimental details which enhance the validity of the results are emphasized. (auth)

27421 (JINR-P-1969) VZAIMODEISTVIE BYSTRYKH PROTONOV S TYAZHELYMI YADRAMI. (Interactions of Fast Protons With Heavy Nuclei). V. S. Barashenkov, V. M. Mal'tsev, and V. D. Toneev (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 14p. Dep.(mn).

Within the framework of the cascade-evaporation model different characteristics of proton interactions with ^{238}U nuclei in the range 100–700 Mev are calculated. The nuclear fission process is taken into account. It is shown that the model is in good agreement with experimental data. A discrepancy is observed only for the yield of some fission products. Possible reasons for this discrepancy are discussed. (auth)

27422 (JINR-P-1970) RASCHET DELENIYA YADER POD DEISTVIEM BYSTRYKH CHASTITS. (A Calculation of Nuclear Fission Induced by Fast Particles). V. S. Barashenkov, V. M. Mal'tsev, and V. D. Toneev (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 8p. Dep.(mn).

On the basis of a consistent statistical consideration of the intranuclear cascade, evaporation, and fission, the yield of nuclear fission products induced by fast particles is calculated. The results of the calculations of ^{238}U fission induced by protons with energy 100–700 Mev are compared with experiment. (auth)

27423 (JINR-P-1972) ISSLEDOVANIYA INTENSIVNOSTEI ZHESTKIKH γ-PEREKHODOV PRI ZAKHVATE REZONANSNYKH NEITRONOV Ba^{135}. (Investigations of Intensities of Hard γ Transitions in the Capture of Resonance Neutrons by Ba^{135}). Yan Urbanets, Yan Vrzal, and Yan Liptak (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1965. 10p. Dep.(mn).

A single-crystal scintillation spectrometer and a three-dimensional analyzer were used to measure the spectra of hard γ quanta in the energy region 4 to 10 Mev. These γ quanta are emitted in the capture of resonance neutrons by ^{135}Ba in the neutron energy range 18 to 1500 ev. The 24.5-ev resonance shows a noticeable anomaly in the intensity of the transitions to the ground and the first excited level. The intensities of these two transitions for 11 resonances of ^{135}Ba are determined, and possible interpretations of the observed anomaly in the 24.5-ev resonance are presented. (auth)

27424 (JINR-P-1978) YADERNYE REAKTSII NA Ir, Ta, I Er, VYZVANNYE PROTONAMI S ENERGIEI DO 85 Mev. (Nuclear Reactions on Ir, Ta, and Er Induced by Protons of Energy up to 85 Mev). V. S. Barashenkov, V. M. Mal'tsev, and T. D. Toneev (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 6p. Dep.(mn)

The relative contribution is investigated of nucleon-nucleus interactions involving the formation of a compound nucleus and of interactions in which the intranuclear cascade is developed and a subsequent evaporation of particles from the residual nucleus occurs. As an example, the proton interaction with Ir, Ta, and Er nuclei at 20 to 80 Mev is considered. (auth)

27425 (JINR-P-2003) ELEKTROMAGNITNYE PEREKHODY V NECHETNYKH NEAKSIAL'NYKH YADRAKH. (Electromagnetic Transitions in Odd-Mass Non-Axial Nuclei). V. V. Pashkevich (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 23p. Dep.(mn).

Electromagnetic transitions in odd nuclei are considered, using a model in which the nucleus is represented by a nonaxial core and an external nucleon whose moment is conserved. The calculation is carried out without using the adiabatic approximation, i.e., without differentiating between single-particle and collective motions. The results are compared with experimental data. (auth)

27426 (JINR-P-2026) O RASSEYANII NEITRONOV NA POLYARIZOVANNYKH YADRAKH, NAKHODYASHCHIZHSYA VO VNESHNIZH POLYAKH. (Scattering of Neutrons on Polarized Nuclei in External Fields). V. G. Baryshevskii, V. L. Lyuboshits, and M. I. Podgoretskii (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics and Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1965. 13p. Dep. (mn).

The scattering of polarized neutrons on polarized nuclei in a magnetic or inhomogeneous electric field is ana-

lyzed. It is shown that the intensity and polarization of the scattered and transmitted neutron beams depend periodically on time. Peaks occurring in the neutron intensity and polarization are considered which can be registered by inertial detectors if interaction of the nuclear levels takes place. (auth)

27427 (JINR-P-2030) O NEUPRUGOM RASSEYANII SLOZHNYKH YADER. (On Inelastic Scattering of Complex Nuclei). F. A. Gareev and V. N. Kalinkin (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 11p. Dep.(mn).

A semiclassical approximation is used to determine the role of various factors which influence the inelastic scattering cross section for complex nuclei. It is shown that a rather simple analysis of experimental data may be made when energies considerably exceed the Coulomb barrier and the charge of the heavy ion is large. (auth)

27428 (JINR-P-2032) RASPAD Pr^{138}. (Pr^{138} Decay). A. S. Basina, T. Bedike, K. Ya. Gromov, B. S. Dzhelepov, N. A. Lebedev, V. A. Morozov, and A. F. Nougorodov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1965. 16p. Dep.(mn).

The gamma, $\gamma-\gamma$- and $\beta^+-\gamma$-coincidence, and conversion-electron spectra of ^{138}Pr were studied. The presence of the 300–1040–800 kev transition cascade in ^{138}Pr decay is proved. The multipolarity of the 300- and 789-kev transitions is determined. Quantum characteristics 4+ and 7– are established for the 1840- and 2140-kev levels in ^{138}Ce respectively. (auth)

27429 (JINR-P-2037) OB AMPLITUDE NEUPRUGOGO RASSEYANIYA BYSTRYKH CHASTITS NA YADRAKH. (On the Amplitude of Inelastic Scattering of Fast Particles by Nuclei). I. Zh. Petkov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 7p. Dep.(mn).

The amplitude of inelastic scattering of particles by nuclei is considered in a high-energy approximation. The problem reduces to the solution of the homogeneous system of the first order differential equations. Approximate expressions for the elastic and inelastic scattering amplitude are given taking into account one or two excited states of a nucleus. The calculated cross section for inelastic scattering of electrons with 0+ state excitation is compared with the corresponding cross section in the framework of the method of distorted waves. (auth)

27430 (JINR-P-2038) ISSLEDOVANIE REAKTSII $He^3 + T$. (An Investigation of the Reaction $He^3 + T$). Nenmin Wang, B. G. Novatskii, G. M. Osetinskii, Nai-gun Tsen, and I. A. Chepurchenko (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1965. 22p. Dep.(mn).

The angular distributions (0 to 135°) and differential and total cross sections for three channels of the reactions $^5He + T$ were measured using an electrostatic generator for accelerating the tritium ions. The energy of ^5He decay into an α particle and a neutron was determined to be 0.84 ± 0.06 Mev. The work was done with a thin gaseous target with an entrance window made of Ni and Al_2O_3 in the energy range 730–1500 kev. (auth)

27431 (JINR-P-2040) γ-γ UGLOVYE KORRELYSTSII PRI RASPADE $Pr^{138} \rightarrow Ce^{138}$. ($\gamma$-$\gamma$ Angular Correlations in the $Pr^{138} \rightarrow Ce^{138}$ Decay). K. Ya. Gromov, I. Demeter, and E. Hadyhakov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1965. 10p. Dep.(mn).

Angular correlations for the 300–1040 and 1040–800 kev cascades were measured. Conclusions about spins and multipolarities are drawn. If some other data are used then the measurement allows all the remaining hypothesis but 7(3)4(2)2(2)0 to be excluded. (auth)

27432 (JINR-P-2052) O SKHEME UROVNEI Sm^{145} IZ RASPADA Eu^{145}. (On Level Scheme for Sm^{145} Decay). I. Demeter, F. Mol'nar, E. Nadzhakov, and A. F. Novgorodov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1965. 17p. Dep.(mn).

The γ spectrum, $\gamma-\gamma$ coincidences, and $\gamma-\gamma$ angular correlations of the $^{145}Eu-^{145}Sm$ decay were investigated using a scintillation coincidence spectrometer. The ^{145}Eu isotope was formed by the α decay of ^{149}Tb and was prepared from the terbium fraction of tantalum target irradiated with 660-Mev protons. A new version for the level scheme of ^{145}Sm is suggested. The relative feeding intensities for various levels by electron capture are estimated. Spin and parity of $5/2^+$ for the 1547-kev level were obtained. Considerations were made showing $1/2^+$ or $5/2^+$ as possible spins for the 1435-kev level. (auth)

27433 (JINR-P-2060) "PEREZARYADKA" NUKLONOV NA YADRAKH. (Charge Exchange of Nucleons by Nuclei). V. N. Mekhedov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1965. 18p. Dep.(mn).

The experimental data concerning the angular distributions, energy spectra, and the probability of emission of fast secondary nucleons from different targets bombarded with high-energy protons or neutrons are treated. These data point to an existence of a specific charge exchange of nucleons by nuclei. This process has some different features depending on which high-energy nucleon (proton or neutron) is incident on the target. (auth)

27434 (JINR-P-2063) ZAKHVAT μ^--MEZONOV LEGKIMI YADRAMI. (The Capture of μ^- Mesons by Light Nuclei). G. Ya. Korenman and R. A. Eramzhyan (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 8p. Dep.(mn).

The probability of the μ^--meson capture from a definite state of the hyperfine structure of a mesic atom is investigated. It is shown that in the case of ^{13}C and ^{19}F, the probability of the capture from the lower state of the hyperfine structure depends only on G_p^2. (auth)

27435 (JINR-P-2116) SINTEZ IZOTOPA 103 ELEMENTA (LOURENSIYA) S MASSOVYM CHISLOM 256. (A Synthesis of Isotope of Element 103 (Lawrencium) With Mass Number 256). E. D. Donets, V. A. Shchegolev, and V. A. Ermakov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1965. 13p. Dep. (mn).

In the nuclear reaction $^{243}Am(^{18}O, 5n)^{256}Lw$, a new isotope of element 103 was synthesized. The half life of the isotope is about 45 sec. The production cross section of ^{256}Lw amounts to 6×10^{-32} cm^2. The identification was made by the decay product, ^{252}Fm. (auth)

27436 (NP-14833) UBER DIE EMISSION VERZOGERTER NEUTRONEN BEI KERNSPALTPROZESSEN. (On Delayed Neutron Emission in Nuclear Fission Processes (thesis)). Hans Juergen Volker Fiedler (Mainz Univ. (West Germany). Naturwissenschaftliche Fakultaet). 1965. 141p. Dep.(mn).

After a review of available data and knowledge on the delayed emission of neutrons in nuclear fission, a study was made to explain the yields of these delayed neutrons in various fission processes by the accumulated fission yields of previously known precursors. These studies led to the following results. The yield of the first four groups of delayed neutrons can be explained in fission reactions with low-energy neutrons through the fission yields of halogen precursors. In fission reactions with excitation energies over 15 Mev, the twice-as-high yields can not be explained by the contribution of halogen precursors. The neutron emission probabilities of halogen and other precursors can be estimated. The calculation of the accumulated fission yields of precursors permits some conclusions on the charge and neutron distribution curves used and on the Z_p functions. The exponential dependence of the neutron yield on fissioning nuclei can be explained. An explanation for the high neutron yields in the fission of ^{232}Th by 14-Mev neutrons was sought experimentally. The investigations were limited to the three longest-lived groups. An indication of the still unknown precursors that contribute significantly to the yields of these groups could not be found. No variation in the experimentally determined total yields could be established in fission with 3- and 11-Mev neutrons (tr-auth)

27437 (NRL-6256) GROUP THEORETIC MODEL INTERACTIONS AS AN APPROACH TO 2s-1d SHELL NUCLEI: THE LEVEL STRUCTURE OF FLUORINE-20. M. de Llano, Jr. (Naval Research Lab., Washington, D. C.). Mar. 10, 1965. 242p. (AD-613008). $6.00(CFSTI).

Based on studies in the theory of continuous groups of transformations, the nuclear shell many-body problem has been reformulated in second quantization language. The methods for simplifying the basic set of state functions by classification according to the group SU(3) are recast into the above-mentioned reformulation. The purpose is to make low-energy nuclear calculations feasible for nuclei with 4 and more particles in the 2s-1d shell and thus render possible the probing for SU(3) symmetries in these nuclei. A hamiltonian model consisting of pairing and quadrupole-quadrupole terms is known to approximate respectively the short- and long-ranged correlations between nucleons given by an arbitrary, reasonably shaped two-nucleon central interaction potential. The former model is generalized to include exchange effects at the long range as well as spin-orbit coupling, and is studied in detail from the viewpoint of its various group symmetries. It is then employed to calculate the low-lying levels of fluorine-20, which show reasonable accord with the empirical level-scheme. (auth)

27438 (PAN-532/I-A) INTERNATIONAL BREMSSTRAHLUNG ACCOMPANYING THE ELECTRON CAPTURE DECAY OF Hg^{197}. A. Jasinski, J. Kownacki, H. Lancman, and J. Ludziejewski (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research). Dec. 1964. 15p. Dep.

The K x-ray coincidence internal bremsstrahlung spectrum was studied with the aid of scintillation spectrometry. The total decay energy was deduced from the end-point of internal bremsstrahlung and was found to be 763 ± 40 kev. The experimental results were compared with the theory of Glauber and Martin for the allowed transitions. (auth)

27439 (PAN-551/VI) ON THE EXISTENCE OF EVENTS WITH LARGE ENERGY TRANSFER INTO NEUTRAL PIONS IN THE INVESTIGATION OF NUCLEAR INTERACTIONS AT MOUNTAIN ALTITUDES. Z. Buja, B. Heller, J. Massalski, and B. Niziol (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research). Nov. 1964. 30p. Dep.

The experimental data were obtained using an apparatus with area of 10 m^2 installed at 3200 m above sea level. The apparatus contained a few layers of emulsion plates and ionization chambers separated by lead and graphite absorbers. Nuclear interactions in which the neutral pions carry away a large fraction (k_{π^0}) of the primary energy are discussed. The observed interactions are not inconsistent with the fireball model, but in events with $k_{\pi^0} \geq 0.6$ it must be assumed that the most energetic pion comes from the excited baryon decay. (auth)

27440 (TID-21812) GAMMA SPECTRA FROM THE DECAY OF NEUTRON-DEFICIENT ISOTOPES. D. P. Donnelly and M. L. Wiedenbeck (Michigan Univ., Ann Arbor). [1963]. Contract AT(11-1)-1112. 8p. Dep. (mn); $1.00(cy), 1(mn) CFSTI.

The gamma ray spectra resulting from the decay of neutron deficient isotopes of Ru and Ni were studied to see if the Van de Graaff accelerator would be useful as a means of producing such radioactive isotopes through the (n,2n) reaction. Fast neutrons were generated by the accelerator by means of T(d,n)^{4}He reactions. A NaI(Tl) detector was used to study the spectra. The results agree qualitatively with previously published work. The results indicate that the Van de Graaff generator is a useful tool in the study of neutron deficient isotopes. (auth)

27441 (TID-21826) THE PRECISION ENERGY MEASUREMENTS OF GAMMA RAYS IN THE ENERGY REGION OF 90-2500 kev. J. J. Reidy (Michigan Univ., Ann Arbor). [1964]. Contract [AT(11-1)-1112]. 12p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

The energies of some gamma rays which follow the decay of ^{82}Br, ^{140}La, ^{160}Tb, and ^{165}Dy were determined. The energies of thirteen gamma rays so far were measured in the ^{160}Tb decay. Some twenty-five gamma rays were observed in the ^{165}Dy decay with measurements on 9 lines being reported. A measurement was also performed on the 2500 kev transition in the decay of ^{140}La. (auth)

27442 (UCRL-11965) ANGULAR DISPERSION OF COINCIDENT FISSION-FRAGMENT TRAJECTORIES ARISING FROM A DISK SOURCE. Paul Concus and Rand L. Watson (Lawrence Radiation Lab., Univ. of California, Berkeley). Feb. 18, 1965. Contract W-7405-eng-48. 16p. Dep.; $1.00(cy), 1(mn) CFSTI.

The angular distribution of coincident fission-fragment trajectories arising from a disk source of arbitrary size is derived theoretically, when two disk detectors of equal size are equidistant from and coaxial with the source. Only the geometric effects are considered; the effects of prompt neutron emission are neglected. The angular distribution is found as a closed-form expression in terms of elementary functions, and graphs are given of the distribution for several size-to-spacing ratios of the source and detectors. (auth)

27443 (ANL-Trans-149) THE EMISSION OF DELAYED NEUTRONS IN NUCLEAR-FISSION PROCESSES. Hans Juergen Volker Fiedler (Mainz Univ. (West Germany). Naturwissenschaftliche Fakultaet). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from p.27-36 of a PhD thesis. 1963. 15p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

The distribution of the primary yields over the members of a certain fission chain is discussed. Mass distributions are presented for ^{252}Cf spontaneous fission, ^{233}U, ^{235}U, and ^{239}Pu thermal fission, and ^{232}Th and ^{238}U fast fission. (C.E.S.)

27444 THE PRODUCTION OF LIGHT MESONIC HYPERFRAGMENTS AND Li^8 FRAGMENTS FROM THE INTERACTIONS OF K^- MESONS OF 1,3 AND 1,5 Gev/c MOMENTA WITH EMULSION NUCLEI. W. Gajewski, J. Suchorzewska, M. F. Votruba, and J. Zakrzewski (Warsaw Univ. and Inst. for Nuclear Research, Warsaw). Acta Phys. Polon., 27: 329-34(Feb. 1965).

The production of light mesonic hyperfragments and ^{8}Li fragments from the interactions of 1,3 to 1,5 Bev/c K^- mesons with emulsion nuclei was investigated. The results are compatible with the assumption that most of the light hyperfragments and ^{8}Li fragments are emitted from excited heavy residual nuclei moving with an average forward velocity $\beta = 0.016 \pm 0.005$. (auth)

27445 THE KNOCK-ON ELECTRONS OF FAST MUONS. B. K. Bandyopadhyay, M. M. Biswas, and R. L. Sengupta (Presidency Coll., Calcutta). Ann. Physik (7), 15: 49-52(1965).

Knock-on electrons produced by muons of different energies were investigated in lead and copper with a cloud chamber by coincidence and anticoincidence technique. The probability of their production in lead is (5.82 ± 0.71)% per 1.27 cms of Pb and in copper (7.64 ± 0.59)% per 1.27 cms of Cu. Angles of emergent secondaries in Pb follow a $\cos^{2.5}\theta$ distribution and in Cu a $\cos^4\theta$ distribution. (auth)

27446 NUCLEAR STUDIES WITH THE 60-INCH SCATTERING CHAMBER: ANGULAR DISTRIBUTIONS FROM CHARGED-PARTICLE REACTIONS. Jan. L. Yntema. Argonne Natl. Lab. Rev., 2: No. 2, 6-8(Apr. 1965).

Some investigations of nuclear structure are summarized in which the 60-in. scattering chamber at the Argonne cyclotron was used to measure the angular distributions for scattering and nucleon-transfer reactions. The scattering chamber is described; and the experimental angular distributions for alpha elastic and inelastic scattering by ^{58}Ni and for the reactions ^{50}Ti(d,p)^{51}Ti, ^{48}Ti(d,^{3}He)^{47}Sc, and ^{49}Ti(d,^{3}He)^{48}Sc are included, together with theoretical predictions. Observations on the ^{89}Y(d,^{3}He)^{88}Sr reaction are mentioned. (D.C.W.)

27447 HYPERFINE STRUCTURE OF THE LEVEL $2^2P_{\frac{1}{2}}$ OF LITHIUM-6 AND LITHIUM-7. George J. Ritter (National Research Council, Ottawa). Can. J. Phys., 43: 770-81(May 1965). (NRC-8349)

The hyperfine structure of the level $2\,^2P_{\frac{1}{2}}$ of both ^6Li and ^7Li was investigated by means of the optical-radio-frequency double-resonance method. The following values were obtained for the magnetic interaction constants of the two isotopes: $a_{\frac{1}{2}}(^6Li) = 17.48 \pm 0.15$ Mc/sec, and $a_{\frac{1}{2}}(^7Li) = 46.17 \pm 0.35$ Mc/sec. The g_j value for $^2P_{\frac{1}{2}}^{\frac{1}{2}}$ level was found to be -0.6668 ± 0.0020. (auth)

27448 ANGULAR MOMENTUM DISTRIBUTIONS IN THE ATOMIC NUCLEI. Jenn-lin Hwang (National Taiwan Univ., Taipei) and Jyi-cherng Horng. Chinese J. Phys. (Taiwan), 2: 80-3(Oct. 1964).

The problem of how many protons (neutrons) of a given orbital angular momentum Planck's constant are to be found in a nucleus of a given proton number Z (neutron number N) is reinvestigated by means of the improved Thomas-Fermi method. Three kinds of nuclear models are calculated. The types of potentials chosen are: a square well potential, the Green's potential, and the Green's potential plus 45 times the Thomas-Frenkel spin-orbit term. The parameters involved in the potentials are adopted from the paper of Hwang and Yang, which may exactly reproduce the nuclear radii, trends of binding energies, and location of 3s and 4s maxima in the neutron scattering cross section. The eigenvalues calculated by Green are used to simplify the procedure of calculation. The results are then compared with the empirical data compiled by Klinkenbeig. For the last type of potential, the calculation is almost perfectly exact. The first appearance of particles of the next higher angular momentum is almost exact for each model. The puzzle in the Yang's treatment of the first appearance problem is then solved. The origin of the appearance of magic numbers in the Yang's calculation is explained in the light of the present theory. (auth)

27449 SOME GEOMETRICAL PROPERTIES OF SPHERICAL SHELLS IMPLYING THE SYSTEMATICS OF NUCLEAR RADII. Jenn-lin Hwang (National Taiwan Univ., Taipei). Chinese J. Phys. (Taiwan), 2: 84-9(Oct. 1964).

Assuming that the nucleon is a ball of radius r(= 1 fm) consisting of an incompressible but a deformable matter, the number of nucleons N which can be inlaid closely into a spherical shell with an outer radius R and an inner radius R−2r is calculated. If the nucleons suffer deformation except along the radial direction of the shell, N/4 equals the number of particles occupying the shells of a harmonic oscillator well (to 2, 6, 12, 20, 30 ...) for R/r = 2.5, 3.5, 4.5, 5.5, 6.5 .... If the nucleons suffer no deformation, N/4 equals the numbers of particles occupying the fourth, fifth, sixth ... shells of a realistic nucleus (to 22, 32, 44 ...) for R/r = 6.0, 7.0, 8.0 .... Applications are made to account for the systematics of nuclear radii. It is shown that a combination of the above properties forms a foundation of the rules proposed previously, that is, the closed shell nuclei of proton (neutron) number, 2, 8, 20, 28, 50, 82, 126 ... have the radii of proton (neutron) density 2.5, 3.5, 4.5, 5.0, 6.0, 7.0, 8.0 ... fm respectively. Finally, a configuration of nucleons within the nucleus which corresponds to the classical picture of nucleus is suggested. (auth)

27450 NUCLEON DENSITIES OF ATOMIC NUCLEI. Jenn-lin Hwang and Chien-ming Wu (National Taiwan Univ., Taipei). Chinese J. Phys. (Taiwan), 2: 90-5(Oct. 1964).

As reported in the previous paper (Chin. J. Phys. 2, 84 1964), two patterns of particle packing in the spherical shell can account for the systematics of nuclear radii, and from them the configuration of nucleons within the nucleus can be obtained in a classical manner. The possibility of such patterns of packing is examined quantitatively, and the wave mechanical correspondence to the objectured nucleon configuration is sought. For these purposes, the nucleon densities of the nucleus are defined and calculated in a classical manner. A universal function is furnished for determining the nucleon densities of any nucleus. The calculation shows that the maximum relative density in the nucleus is only 0.79 allowing the suggested patterns of particle packing. The calculated densities for nucleus of N = Z = 82 and for that of ^{197}Au are then compared respectively with the Rotenberg's self-consistent field calculation and with the shell model wave function calculation of Ross, Mark and Lawson. A good conformity and a significant correspondence are obtained. (auth)

27451 STUDY OF THE $\beta(2^- \rightarrow 2^+)$ TRANSITION OF GOLD-198. β SPECTRUM AND ANGULAR CORRELATION WITH THE 412-kev γ RAY. Jean Lachkar, Janine Perchereau, and Georges Ambrosino (Laboratoire M. de Broglie, Bretigny-sur-Orge and Montrouge, France). Compt. Rend., 260: 2184-7(Feb. 22, 1965). (In French)

The β spectrum of ^{198}Au in coincidence with the 412-kev γ ray was measured with a 4π scintillation spectrometer. In the Fermi-Kurie diagram, the spectrum deviates from linear form. The form factor C(W) is $C(W) = 1 - \underline{a}W + \underline{c}W^2$, $\underline{a} = 0.34 \pm 0.04$ and $C = 0.10 \pm 0.02$. The angular correlation as a function of the energy of emission of the electron was measured with good resolution. It increases monotonically with energy to attain 3% at the normal energy. The precise interpretation of the form of the spectrum requires consideration of all the matrix elements relative to the transition. (tr-auth)

27452 MULTIPOLAR CHARACTER OF THE 340-kev γ TRANSITION OF THE DECAY $^{151}Pm \rightarrow {}^{151}Sm$. Jean Berthier, Jean-Claude Hocquenghen, and Pierre Locard (Faculte des Sciences, Grenoble, France). Compt. Rend., 260: 2785-8(Mar. 8, 1965). (In French)

The E_1 character of the 340-kev transition is shown by comparing its conversion coefficient α_K with that the neighboring energy transition (364 kev) of ^{152}Gd. (tr-auth)

27453 α SPECTRA OF LONG PATH OF POLONIUM-214 (RaC') AND 212 (ThC'). Chin-Fan Leang (Centre de Spectrometrie Nucleaire et Spectrometrie de Masse, Orsay, France). Compt. Rend., 260: 3037-40(Mar. 15, 1965). (In French)

The α spectra of polonium-214 and -212 were studied by magnetic spectrography. Two new groups were found in the spectra of ^{214}Po. (tr-auth)

27454 THE DETERMINATION OF NUCLEAR MOMENTS FROM THE ANGULAR DISTRIBUTION OF RADIATION EMITTED BY DYNAMICALLY POLARIZED NUCLEI. M. Odehnal and M. Sott (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Czech. J. Phys., 15: 307-16(1965).

A method is suggested which allows the establishment both of the sign and magnitude of quadrupole interaction and the magnitude of magnetic moment of radioactive nuclei. The dynamic polarization of these nuclei is assumed as well as the subsequent change of the degree of orientation (by means of saturation of some suitable nuclear transitions). The comparison of resonant frequencies for negative and positive initial polarization gives the values of the above-mentioned quantities. The angular distribution of the intensity of radiation emitted is used for the detection of changes in the degree of polarization. (auth)

27455 DECAY OF Hf^{172}. V. Brabec and J. Jursik (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Czech. J. Phys., 15: 317-24(1965).

The internal conversion spectrum of ^{172}Hf was examined with an intermediate image magnetic spectrometer. The gamma spectrum and gamma-gamma coincidence spectrum were studied by means of scintillation spectrometers. The half life of the 65.9-kev excited level in ^{172}Lu was found to be $T_{\frac{1}{2}} = (3.32 \pm 0.20) \times 10^{-7}$ sec. The proposed decay scheme is discussed. On the same apparatus the half life of the 206.25-kev excited level in ^{187}Re was measured, and the result is $T_{\frac{1}{2}} = (5.05 \pm 0.13) \times 10^{-7}$ sec. (auth)

27456 QUADRUPOLE SPLITTING OF THE MAGNETIC RESONANCE SPECTRUM OF ^9Be IN CHRYSOBERYL. Harry L. Reaves and Thomas E. Gilmer, Jr. (Virginia Polytechnic Inst., Blacksburg). J. Chem. Phys., 42: 4139-40(June 15, 1965).

The quadrupole coupling constant, the asymmetry parameter, and the orientation of the principal axes of the electric field gradient tensor were determined for the ^9Be sites in chrysoberyl. These values were found to be: $\eta = 0.90 \pm 0.01$ and $|eQ\phi_{zz}/h| = 318 \pm 2$ kc/sec. Two different types of sites were found for the beryllium. These two

sites were equivalent. One of the principal axes was found to be parallel to the crystalline c axis. (auth)

27457 ON THE INTERFERENCE EFFECT IN ^{23}Na EXCITATION BY PROTONS. V. A. Dzhrbashyan (Inst. of Physics, Erivan). Dokl. Akad. Nauk Arm. SSR, 40: 19-20(1965). (In Russian)

Various theoretical and experimental determinations of the contribution of the interference of Coulomb and nuclear-resonance excitations to the total cross section of the ^{23}Na(p,pγ)^{23}Na reaction at low energies are compared. The inclusion of the interference contribution is found to produce better agreement of the experimental results with theory. The matrix elements used for the transformation from the representation of the total moment j to the representation of the spin of the s channel are discussed. (M.J.T.)

27458 NEUTRON SPECTROSCOPY STUDIES OF NUCLEAR LEVELS. NEUTRON CROSS-SECTIONS OF STRONTIUM ISOTOPES BETWEEN 2-5 AND 25,000 ev. Yu. V. Adamchuk, L. S. Danelyan, S. S. Moskalev, G. V. Muradyan, and Yu. G. Shchepkin (Kurchatov Inst. of Atomic Energy, USSR). Euro Nucl., 2: 183-5(Apr. 1965).

The total neutron cross sections and radiative-capture cross sections of ^{84}Sr, ^{86}Sr, ^{87}Sr, and ^{88}Sr were measured in the energy range from 2.5 to 25,000 ev, using targets of strontium carbonate. The parameters of neutron resonances were derived, and the resonances were assigned to isotopes. The strength functions of the isotopes were also obtained; the values for the even isotopes verify that the experimental strength functions in the region A ~ 100 are in agreement with the predictions of the optical model. A number of weak levels were detected, which were ascribed to p-wave neutrons. (D.C.W.)

27459 GENERALIZED APPROXIMATE EXPRESSIONS OF POTENTIAL BARRIER PENETRANCE. S. Kristov. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk., 11: 221-37(1963). (In Bulgarian)

A stricter representation is given of the formerly suggested quasi-classical formula of potential barrier penetrance. This formula represents a generalization of the well-known expression derived by the method of Wentzel-Brillouin-Kramers. By means of this generalization it is possible to calculate the penetrance for arbitrary values of the particle energy. With the help of the generalized quasi-classical formula, an analytical expression is derived for the penetrance of a rather general type of barriers including the barrier of Eckart and the parabolic barrier as particular cases. Finally, formulas are derived for evaluating the role of the tunnel effect in the generalized barrier of Eckart, assuming that the Boltzman law of distribution of the particle energy holds. (tr-auth)

27460 NUCLEON-NUCLEUS COLLISIONS AT HIGH ENERGIES. V. V. Guseva, S. A. Dubrovina, A. M. Lebedev, A. E. Morozov, L. A. San'ko, V. V. Sokolovskii, S. A. Slavatinskii, and B. V. Tolkachev (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1761-3(Nov. 1964). (In Russian)

An attempt was made to describe the interaction of high-energy (10^{11} to 10^{12} ev) nucleons with complex nuclei from the standpoint of a succession of statistically independent encounters of the incident particle with the nucleons of the target nucleus. The nucleon interaction cross sections were calculated by the classical method of impact parameters. The Hofstadter data on electron scattering were used to evaluate the proton densities. Numerical calculations were carried out for the cross sections for nuclei with A = 6, 9, 12, 14, 16, 56, 122 and 207. The calculated values of σ are in good agreement with the power function $\sigma = \sigma_0 A^{\frac{2}{3}}$. Further, the values of the mean fraction $\bar{\Delta}$ of the energy retained by the nucleon after interaction with a complex nucleus were calculated. The results of these calculations are compared with some experimental data. The agreement is best (but far from perfect) on the assumption of an inelasticity coefficient 0.35 ($\bar{\Delta}_0 = 0.65$). The values of the anisotropy parameter (proportional to σ/σ isotropic) as a function of the jet multiplicity (which may be taken as a measure of the length of the reaction tube or the number of nucleons with which the incident particle interacts) obtained by interpolation of the experimental data are compared with the functional dependence calculated on the basis of hydrodynamic theory; here the disagreement is substantial. This is interpreted as an argument in favor of the assumption of successive interaction of the incident nucleon with the nuclear nucleons. (ATD)

27461 INELASTICITY OF THE INTERACTION OF COSMIC PARTICLES WITH LIGHT AND HEAVY NUCLEI. S. A. Azimov, A. M. Abdullaev, V. B. Lugovskoi, V. M. Myalkovskii, V. B. Tokarskii, and T. S. Yuldashbaev (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1773-5(Nov. 1964). (In Russian)

The relation between the coefficient of inelasticity and primary energy was studied in the interval from 70 to 700 Bev, using the calorimeter of a Cherenkov counter. Measurements were made at the mountain station of the Institute of Nuclear Physics of the Uzbek SSR Academy of Sciences in Kum-Bel pass at an altitude of 3200 m above sea level. The coefficient was found to be only slightly dependent on the energy of the incident particles in this energy interval. Values of the coefficient are given for iron and carbon. (ATD)

27462 STUDY OF THE AMOUNT OF ENERGY TRANSMITTED TO THE SOFT COMPONENT BY PARTICLES INTERACTING WITH CARBON NUCLEI. S. A. Azimov, Yu. V. Polyak, and R. S. Abdullaev (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1776-7(Nov. 1964). (In Russian)

Measurements were conducted at the mountain station of the Uzbek Academy of Sciences. The station is 3170 meters above sea level. The apparatus was operated for 600 hr. It consisted of 11 series of ionization chambers (150 in all) and three series of hodoscope counters (240 in all) placed between layers of graphite, lead and iron. Each counter was connected to an individual amplifier. All energy yields of more than 100 Bev were recorded. The average coefficient of energy transfer to the electron-photon component was determined to be 0.29 ± 0.06. (ATD)

27463 MATERIALY XIV EZHEGODNOGO SOVESHCHANIYA PO YADERNOI SPEKTROSKOPII (TBILISI, 14-22 FEBRALYA 1964 G.). (Report of 14th Annual Conference on Nuclear Spectroscopy, Tbilisi, Feb. 14-22, 1964). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 93-343(Jan. and Feb. 1965 Issues). (CONF-640205)

Fifty-one papers are included. Separate abstracts were prepared for 46. Five papers were previously abstracted for NSA; see abstracts 18: 21177, 21179, 30835, 32817, and 34766. (M.J.T.)

For abstracts of individual papers see: 26683, 26684, 26685, 26686, 26687, 26688, 26689, 26930, 26931, 26932, 26933, 26934, 26935, 27185, 27186, 27187, 27292, 27464, 27465, 27466, 27467, 27468, 27469, 27470, 27471, 27472, 27473, 27474, 27475, 27476, 27477, 27478, 27479, 27480, 27481, 27482, 27483, 27484, 27485, 27486, 27487, 27488, 27489, 27490, 27491, and 27492.

27464 EFFECT OF TENSOR FORCES IN THE SPECTRA OF ODD-ODD NUCLEI. J. O. Rasmussen and Y. E. Kim (Univ. of California, Berkeley). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 94-9(Jan. 1965). (In Russian)

Calculations of the effect of tensor forces on energy-level transitions in odd-odd nuclei were carried out on an IBM 7090, using an n-p interaction near to that in free space. Results are surveyed for three cases — j_p or j_n equal to $\frac{1}{2}$; $j > \frac{1}{2}$, for strong Nordheim rule; $j > \frac{1}{2}$, for weak Nordheim rule. (M.J.T.)

27465 NEW DATA ON THE EXCITED LEVEL SCHEME OF THE ODD-ODD NUCLEUS Pa-234. R. Fushe. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 100-1(Jan. 1965). (In Russian)

A study was carried out of the gamma spectrum and the spectrum of conversion electrons in the beta decay ^{234}Th → ^{234}Pa. It was found that the multipolarity of the 29-kev

transition of ^{234}Pa is E2, contrary to previous experiments. The decay scheme of ^{234}Th and ^{234}Pa is shown, giving values of spin-parity, multipolarity, branching ratio, and half life. (M.J.T.)

27466 CONVERSION MATRIX ELEMENTS. I. M. Band, M. A. Listengarten, and L. A. Sliv. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 102-4(Jan. 1965). (In Russian)

An internal conversion coefficient is expressed as the sum of the so-called partial coefficients pertaining to transitions of the electron to different final states of the energy continuum, characterized by the quantum number $\varkappa$: $\alpha_q^{(\tau L)} = \Sigma_\varkappa |M_\varkappa|^2 \equiv \Sigma_\varkappa |\mathrm{Re}M_\varkappa + i\,\mathrm{Im}M_\varkappa|^2$. Here $\alpha_q^{(\tau L)}$ is the conversion coefficient of type τ gamma radiation (E = electric; M = magnetic) of multipole order L on the q-th shell or subshell; and $M_\varkappa \equiv M_\varkappa^{(\tau L)}$ is the partial conversion matrix element. These matrix elements are intermediate results in calculating internal conversion coefficients, but they also are of independent value and are used in solving other problems. The $M_\varkappa$ for E1, E2, M1, and M2 transitions was calculated for the following values of the atomic number and transition energy $k = \hbar\omega/mc^2$: K-shell: Z = 81, 84, 88, 92, $0.20 \le K \le 5.0$, L-shell: Z = 49, 53, 57, 61, 65, 69, 73, 77, 81, 84, 88, 92, 95, 98, $0.05 \le K \le 0.70$. The algebraic expressions used for the matrix elements are adduced. (ATD)

27467 A FIELD MODEL OF NUCLEAR INTERACTIONS. Yu. V. Tsekhmistrenko. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 124-7(Jan. 1965). (In Russian)

A modification is proposed of the dispersion model of nuclear reactions developed by Amador and Shapiro with the aid of modern field theory techniques. The modification is intended to avoid the assumption of analyticity of the reaction amplitude and the difficulties encountered in dealing with certain types of reactions, such as those involving a compound nucleus. In the proposed theory each nucleus is treated as an elementary particle associated with a field, the transformation properties of which depend on the properties of the nucleus, and nuclear processes are classified according to the number and kinds of particles present in the intermediate state. Nuclear processes are described by the diagrams introduced by Hugenholtz. These diagrams are summed with the elimination of self-energy diagrams so that each line represents a physical or dressed particle, and the renormalized vertex parts are regarded as constants. Complex diagrams are expressed in terms of diagrams containing only three-line vertices and the vertex parts are evaluated from experimental data. The method is illustrated by calculations relating to (d,p), (p,d), (n,n), and (γ,n) reactions, and relations are derived among the cross sections of these processes for zero orbital angular momentum. The theory encounters difficulties in the case of nonvanishing orbital angular momentum, and general suggestions are made for its further modification. (ATD)

27468 DECAY SCHEMES FOR ISOMERIC Sn^{117} AND Sn^{113}. E. D. Khulelidze, V. L. Chikhladze, and V. G. Onufriev. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 133-8(Jan. 1965). (In Russian)

The γ-ray and internal conversion spectra of ^{117m}Sn and ^{113}Sn were investigated. The material was prepared by prolonged bombardment of cadmium foil with 21-Mev α particles and subsequent chemical separation of the tin fraction without carrier. The spectra were observed after a week's delay to permit the short-lived activities to subside. In addition to ^{117m}Sn and ^{113}Sn, the material contained 250-day ^{119m}Sn, the low energy γ rays from which, however, caused no difficulty. The 325-kev γ rays of ^{117m}Sn reported by Kolebin were not observed, and it is concluded that their intensity can not exceed 0.05% that of the 159-kev γ rays. The results obtained from the observations of the ^{113}Sn spectra are in complete agreement with those of Phillips and Hopkins and accordingly in disagreement with those of several other groups. It is concluded that the contradictions could be avoided by the assumption that the spin of the ground state of ^{113}Sn is $^3/_2$ rather than $^1/_2$ and that the spin of the isomeric state is $^9/_2$ rather than $^7/_2$. A direct determination of the spin of the ground state of ^{113}Sn and a more accurate evaluation of the spin of the ^{113}In 650-kev level are regarded as desirable. (ATD)

27469 LEVEL DIAGRAMS OF La^{139} AND Pr^{141}. D. G. Alkhazov, K. I. Erokhina, and I. Kh. Lemberg. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 139-48(Jan. 1965). (In Russian)

The nuclear levels of ^{139}La and ^{141}Pr, excited by Coulomb interaction with 52 Mev quintuply ionized nitrogen ions, were investigated by γ-γ coincidence and by coincidence of γ rays with recoil nitrogen ions. The γ-γ coincidences were observed with two 4×4 cm^2 NaI(Tl) scintillators. The resulting level diagrams with the energies and possible spins and parities of the levels and relative transition probabilities are shown. Results are compared with those of other workers. It is concluded that the level diagram for ^{139}La of Wasson and Coryell (J. Inorg. and Nucl. Chem. 20: 1, 1961) is incomplete and that of Jastrzebski (J. phys. et radium 21: 12, 1960) is incorrect. All the levels of ^{141}Pr observed in the present work were also found by Cohen and Price (Phys. Rev. 123: 283, 1961). (ATD)

27470 INVESTIGATION OF THE Ce^{134}–La^{134}–Ba^{134} DECAY CHAIN. V. R. Burmistrov, Yu. A. Andreev, A. D. Vongai, S. P. Karetskaya, G. D. Latyshev, and O. D. Kovrigin. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 144-50(Jan. 1965). (In Russian)

The ^{134}Ce–^{134}La–^{134}Ba decay chain was investigated by direct measurement of the positron, γ-ray and internal-conversion spectra and by observation of the γ-γ and positron-γ coincidences. The source was prepared by 2 hour bombardment of a tantalum target with 660-Mev protons and subsequent chromatographic separation of the cerium fraction. The positron spectra were observed with a double focusing beta spectrometer having a resolution of 9% and also, in coincidence with γ rays, with a 3 cm diameter stilbene scintillator. The energy analysis of the coinciding radiations was performed by the usual fast-slow coincidence technique with a resolving time of 4×10^{-8} sec in the fast channel. The observed spectra are presented graphically and are discussed in some detail. The positron spectrum was resolved into three components with maximum energies of 1.01, 1.8, and 2.38 Mev respectively. The intensity of the 1.8-Mev positron emission was very low, and this component was observed only in coincidence with 0.6-Mev γ rays. The intensity of the 1.01-Mev positron component was 18% of the total. These three positron components and two γ transitions of 0.605 and 1.47 Mev energy are attributed to the decay of ^{134}La in accord with the work of Stover and Girgis and Lieshout. The 1.47-Mev γ transition is associated with a level excited by the 1.01-Mev positron decay. The possibility of a 10% systematic error in the positron energy measurements is mentioned. (ATD)

27471 CONCERNING THE Ce^{134}–La^{134}–Ba^{134} DECAY CHAIN. E. I. Biryukov, V. T. Novikov, and N. S. Shimanskaya. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 151-6(Jan. 1965). (In Russian)

The ^{134}Ce–^{134}La–^{134}Ba decay chain was investigated by observing the positron and γ-ray spectra and γ-γ coincidences. The material was prepared by bombarding tantalum targets with 660-Mev protons and separating the cerium fraction. The spectra were examined 1.5 weeks after bombardment to permit short-lived activities to subside. Rapid (1 to 2 minute) chemical separations of La from the equilibrium mixture were performed to distinguish between effects of the Ce and the La decays. The ratio of Kx to annihilation radiation for the La decay was measured with the separated material by means of a 4×4 cm^2 4π CsI scintillator. From the results of this measurement and a similar measurement with the Ce-La equilibrium mixture it is concluded that the disintegration energy of ^{134}Ce is 120 kev. The positron spectrum of the equilibrium mixture was observed with a 2×3 cm^2 anthracene crystal. The maximum positron energy was found to be 2.75 Mev. Seven γ rays with energies from 600 to 2520 kev were observed; of these only the first was previously reported. These γ rays all fell off in intensity with the Ce half life, and their relative intensities did not change when the La was removed. The γ rays are, accordingly, all attributed to transitions in ^{134}Ba. A tentative decay scheme is presented. (ATD)

27472 INTERNAL CONVERSION ELECTRONS OF Te^{132}. Yu. F. Ivanov, I. A. Rumer, and A. Ya. Bukach. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 157-8(Jan. 1965). (In Russian)

The internal conversion spectrum of ^{132}Te was observed with a $\pi\sqrt{2}$ double focusing β spectrometer. The ^{132}Te was separated from the fission fragments of uranium irradiated for 5 days with a 2×10^{13} cm^{-2} sec^{-1} thermal neutron flux. The radioactive contamination of the separated Te did not exceed 3%. Eight conversion lines were observed, and 6 of them are assigned to the two known γ transitions. Internal conversion coefficients were calculated on the assumption that the two γ rays are in cascade. The internal conversion coefficients obtained for the softer γ rays differ greatly from those obtained by Cheever et al. (Phys. Rev. 110: 922, 1958). (ATD)

27473 NEW DATA ON THE CONVERSION ELECTRONS FROM THE LONG-LIVED ISOTOPES IN THE LUTETIUM FRACTION FROM PROTON-BOMBARDED TANTALUM. G. I. Sychikov, O. D. Kovrigin, G. D. Latyshev, G. A. Londarenko, and A. F. Novgorodov. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 159-62(Jan. 1965). (In Russian)

The internal conversion electrons from the lutetium fraction of a tantalum target bombarded for 10 hours with 660-Mev protons were observed over the $H\rho$ range from 400 to 2200 Oe cm with a large double-focusing magnetic β spectrometer having a momentum resolution of 0.2% and a transmission factor of 0.65% of 4π. Two sources, both prepared by electrolysis, were employed, and the measurements were begun 9 months after a double chromatographic separation of lutetium from the accumulated rare earths. Seventeen conversion lines were identified with 12 transitions in ^{177}Hf and 5 lines with 3 transitions in ^{177}Lu. Several other conversion lines were ascribed to ^{173}Lu decay (transitions in ^{173}Yb). The responsible nucleus was identified in each case by the half life of the conversion line. There was no appreciable contamination with ^{172}Hf and ^{175}Hf. Relative intensities were measured, and the multipolarities of the 3 ^{177}Lu transitions were determined. The results concerning the ^{177}Lu transitions are in agreement with the findings of Olebent and Alexander, Boehm, and Kankeleit, and it is concluded that isomeric ^{177m}Lu is produced by the reaction $^{181}Ta(p,3p2n)$. (ATD)

27474 GAMMA RADIATION FROM Pu^{241}. I. A. Baranov, V. V. Berdikov, A. S. Krivokhatskii, and A. N. Silant'ev. Akad. Nauk SSSR, Ser. Fiz., 29: 163(Jan. 1965). (In Russian)

The γ-ray spectrum of ^{241}Pu was observed by the α-γ coincidence method, employing an α spectrometer with a silicon surface barrier detector adjusted to the ^{241}Pu α-particle peak and a scintillation γ spectrometer in coincidence. Two γ rays were observed, with energies of 95 and 145 kev and absolute intensities of 51 and 7.5%, respectively. The absolute intensity of the 95 kev gammas is not in agreement with the findings of Freedman, Wagner, and Engelkemeier (Phys. Rev. 88: 1155, 1962). By assuming that the 95-kev radiation is K x radiation from the conversion of the 145-kev γ transition it is found that the K conversion coefficient of the latter is 6.6, which corresponds to an M1 transition. (ATD)

27475 INVESTIGATION OF INELASTIC SCATTERING OF PROTONS BY Al^{27} IN THE EXCITATION ENERGY RANGE FROM 3.5 TO 5.0 Mev. S. S. Vasil'ev, T. N. Mikhaleva, and D. L. Chuprunov. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 181-5(Jan. 1965). (In Russian)

The inelastic scattering of protons by ^{27}Al was investigated. The protons were accelerated to energies of about 6.5 Mev by the 120-cm cyclotron of Moscow State University. The proton beam was focused with quadrupole lenses, magnetically analyzed by 45° deviation, and collimated through a distance of 3.7 m. Currents to 1 μamp were available at the target. The 0.97 mg/cm^2 aluminum foil target was made from 99.9% pure crystalline aluminum. The scattered protons were detected with a CsI(Tl) scintillator with an energy resolution of 2.3%. Energies of eight excited states of ^{27}Al were determined in the range from 2.2 to 4.8 Mev; these energies were in satisfactory agreement with previous data. Absolute cross sections were determined by comparison with the known elastic scattering cross section. Angular distributions of the scattered protons from 6 of the levels were obtained for incident proton energies of 6.39 and 6.56 Mev. These distributions were all symmetric about 90° and independent of incident proton energy, from which it is concluded that the scattering proceeds via compound nucleus formation. Calculations based on the statistical model reproduced the observed angular distributions very well, and from such calculations the spins and parities of two of the levels and the parities and possible spins of three other levels were determined. (ATD)

27476 THE ABSORPTION OF STOPPED π^- MESONS BY C^{12} NUCLEI. N. S. Zelenskaya, Yu. F. Smirnov, and N. P. Yudin (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 186-90(Jan. 1965). (In Russian)

Experimental data of A.T. Varfolomeyev (Zhur. eksp. i teor. fiz. 42: 713, 1962) on the $^{12}C + \pi^- \rightarrow 2\alpha + t + n$ reaction are interpreted. Varfolomeyev measured the excitation curve of ^{11}B, the energy spectra of the emitted α particles and tritons, and the t-n angular correlation. The ^{11}B excitation curve had two maxima, at 20 and about 35 Mev. The 20-Mev maximum is due to ejection of a nucleon from the s shell. The 35 Mev maximum is ascribed to absorption of the π^- meson by an α-particle cluster in the ^{12}C nucleus. The α-particle and triton energy spectra and the t-n angular correlation were calculated on the basis of the α-particle absorption mechanism, and the agreement obtained between theory and calculation was very good in the case of the angular correlation and not bad in the case of the energy spectra. The peaks in the energy spectra are due to α-α and α-t interaction in the final state. It is concluded that π^- capture in ^{12}C is due to single-nucleon and α-particle absorption. It is suggested that the α-particle absorption mechanism will also be important in π^- capture in ^{16}O, but that in other nuclei, specifically in ^{14}N, the two-nucleon absorption mechanism may predominate. (ATD)

27477 RADIATIONS FROM Cr^{49}, Ge^{69}, AND Ga^{68}. K. A. Baskova, S. S. Vasil'ev, M. A. Khamo-Leila, and L. Ya. Shavtvalov. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 200-9 (Feb. 1965). (In Russian)

The positron and gamma spectra of ^{49}Cr, ^{69}Ge, and ^{68}Ga were investigated to obtain further information concerning the decay of odd nuclei in which a proton becomes an even neutron as the result of positron decay and to extend to a larger number of nuclei the linear relation found by Everling between mass number and decay energy. The investigated isotopes were obtained by bombarding enriched targets with deuterons or alpha particles from a cyclotron. The β spectra were observed with a thin-lens magnetic spectrometer, and the γ spectra with a scintillation counter and a 100-channel pulse analyzer. For β-γ coincidence measurements a single-channel γ spectrometer was used. The ^{49}Cr β spectrum contained three components, including a weak (6%) component with end-point energy 800 kev. Five γ lines were observed, of which one at 850 kev is new and one at 620 kev has been controversial. The β spectra of ^{69}Ge and ^{68}Ga had two components each, in agreement with previous findings. A 1600-kev γ ray was found in the ^{68}Ga spectrum, and a previously reported 2320-kev γ ray was not confirmed. Coincidences between various β components and γ rays were observed, and these are discussed in detail with respect to the level diagrams and decay schemes. Attempts to determine the ground state spins and parities of the investigated nuclides from Everling plots were not successful, partly because of distortion of the linear relation by the effects of subshell completion, and partly because of insufficient data concerning neighboring nuclei. It was possible to conclude only that if the ground state of ^{69}Ge is odd with spin $5/2^-$, as is expected on the basis of the shell model, the ground state spin and parity of ^{67}Ge must also be $5/2^-$. (ATD)

27478 ELASTIC SCATTERING OF PROTONS BY Li^7 NUCLEI. G. B. Andreev, A. S. Deineko, and I. Ya. Malakhov (Inst. of Physics and Tech., Academy of Sciences,

Ukrainian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 210-12(Feb. 1965). (In Russian)

Elastic scattering cross sections of ^{7}Li nuclei for 1.2 to 3 Mev protons were measured at angles of 90, 109.9, 125.3, and 140.8° in the cms. The measurements were undertaken to provide data for a phase-shift analysis from which it is hoped that the spin and parity of the 19.1-Mev ^{8}Be level can be determined. The target was a thin LiF film of natural isotopic composition on an equally thin carbon backing, the thickness of the whole being of the order of tens of mg/cm^2. The scattered protons were analyzed with a magnetic spectrometer capable of clearly separating the ^{6}Li and ^{7}Li peaks at all four angles. The existence of a resonance of width greater than 300 kev at a proton energy of 2.1 Mev, corresponding to the 19.1-Mev ^{8}Be level, was confirmed, and an anomaly in the elastic scattering cross section was observed at the 1.88-Mev threshold for neutron emission. The 19.22-Mev ^{8}Be resonance that appears in the ^{7}Li(p,n) reaction did not appear in the elastic scattering. No narrow resonances were found in the proton energy range from 2.4 to 3.8 Mev. (ATD)

27479 PHOTODISINTEGRATION OF Zr^{90}. B. S. Ishkhanov, K. V. Shitikova, and B. A. Yur'ev. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 216-20(Feb. 1965). (In Russian)

The dipole photoabsorption cross section of ^{90}Zr was calculated on the basis of the shell model with δ-function residual interactions to determine the importance of residual interactions in medium mass nuclei. The parameters of the residual interaction potential were chosen so as to obtain agreement between the calculated position of the giant resonance maximum and the experimental (γ,n) peak. These parameters were intermediate between those for ^{40}Ca and ^{208}Pb and were thus reasonable. Taking account of the residual interactions in the diagonal approximation produced no significant effect; the main transitions were concentrated in the region from 7 to 11 Mev. When the nondiagonal part of the residual interaction was taken into account, a single 16.0 Mev level of less than 300 kev width accounted for nearly all of the dipole sum. The small width of this level in comparison with those of lighter nuclei is ascribed to the shift of the giant resonance to lower energies and the increase of the Coulomb and centrifugal barriers, enhancing the contribution of single-particle states with large angular momentum. This theory does not account for the observed shape of the giant resonance; moreover, the theory predicts that the (γ,n) and (γ,p) peaks will coincide, whereas experiment shows them to be separated by some 4 to 5 Mev. The energy distribution of the photoprotons was calculated on the basis of the shell model. Comparison with experiment showed that many more levels are involved than the shell model would indicate. The photoproton energy distribution was accordingly calculated on the basis of the statistical model with pairing taken into account. Reasonable agreement with experiment was obtained only in the low energy region. (ATD)

27480 INVESTIGATION OF THE $Ca^{40}(\gamma,p)$ REACTION. B. S. Ishkhanov, I. M. Kapitonov, E. N. Kornienko, V. G. Shevchenko, and B. A. Yur'ev (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 221-4(Feb. 1965). (In Russian)

The energy and angular distributions of photoprotons from ^{40}Ca nuclei by 18, 22, and 25 Mev bremsstrahlung from a 35 Mev betatron were determined. A 4.4-mg/cm^2 metallic calcium target having natural isotopic composition was employed. The proton energy distribution from 18-Mev bremsstrahlung showed clear peaks at 2.8 and 6.5 Mev with indications of the presence of numerous other peaks. These maxima persisted in the distribution from 22-Mev bremsstrahlung and other maxima developed, including a broad maximum centered in the 8 to 9 Mev region. This last maximum appears to be split in the case of photoprotons from 25 Mev bremsstrahlung. Possible origins of these maxima are discussed in terms of the level structure of ^{40}Ca. The angular distributions were all symmetric about 90° within the experimental error. Protons of energy greater than 7.5 Mev from 22 Mev bremsstrahlung were isotropically distributed. The angular distribution of protons of the same energy range ejected by 23 Mev bremsstrahlung was described by $1+\sin^2\Theta$. (ATD)

27481 DISINTEGRATION OF DEUTERONS INCIDENT TO THEIR SCATTERING FROM LIGHT NUCLEI. E. Ismatov. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 225-9(Feb. 1965). (In Russian)

Angular and energy distributions of protons from the (d,np) reaction were calculated, taking into account the proton and neutron interactions with the nucleus, the p-n interaction in the final state, and the nuclear recoil. Previous formulas of Sitenko for the proton angular and energy distributions are generalized to take account of nuclear recoil. The theoretical proton energy distributions for the ^{4}He(d,pn) ^{4}He reaction at several scattering angles and the angular distributions for several proton energies are presented graphically for incident deuteron energies of 14.6 and 20.2 Mev. Satisfactory agreement is shown between theory and the experimental data of Artemov and Vlasov. (ATD)

27482 PHOTODISINTEGRATION OF Ca^{40}. K. V. Shitikova and E. L. Yadrovskii. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 230-5(Feb. 1965). (In Russian)

The dipole photodisintegration cross section of ^{40}Ca was calculated on the basis of the shell model with finite range residual interactions. The residual interactions were represented by a Gaussian potential well of 1.73-fermi radius. The positions of the $I^{\pi} = 1^{-}$, T = 1 levels and their γ absorption cross sections were calculated for a number of different depths of the potential well and types of exchange force. It was found that the position of the giant resonance depends appreciably on the strength of the interaction and is in agreement with experiment for a potential well depth of 60 Mev. Calculations of the (γ,p) and (γ,n) cross sections were performed with a 60 Mev residual interaction containing 30% Wigner, 30% Majorana, and 40% Heisenberg forces, and the calculated energy distributions of the photoprotons and photoneutrons are compared with previous experimental results. The residual interactions were found to lead to the formation of a single isolated level with decay width 1.5 Mev which accounts for nearly all of the dipole sum. The theory thus gives correctly the position of the giant resonance but not its shape. The theoretical energy spectrum for photoprotons from 18-Mev bremsstrahlung had too few peaks to give a good account of the experimental results. Better qualitative agreement between theory and experiment was obtained for 25-Mev bremsstrahlung, and an identification of the transitions responsible for seven of the observed maxima in the proton energy spectrum is attempted. The theory correctly predicts the presence of soft protons. It is concluded that better agreement can be obtained only by including other effects, such as phonon excitation of the core. (ATD)

27483 INVESTIGATION OF THE REACTION $He^4 + p \rightarrow He^3 + 2N + x\pi$ AT A PROTON ENERGY OF 660 Mev. V. N. Kuz'min and R. M. Yakovlev. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 236-8(Feb. 1965). (In Russian)

A gaseous target was employed, and ^{3}He recoils were recorded at angles of 15, 30, 60, 110, and 150° with nuclear emulsions. From 1000 and 1500 particles were counted at each angle. From the observed recoil energy distribution, the neutron momentum distribution in the ^{4}He target was calculated on the assumption that the reaction proceeds by direct interaction of the incident proton with a ^{4}He neutron, and the result is presented graphically. This calculation neglected tensor forces, spin-orbit coupling, and the interaction between the initial and final states. In order to test whether neglect of these factors is justified, the recoil energy distributions at the larger angles were calculated from the observed distribution at 30°. Good agreement was found except at 150°. At this angle the experimental energy distribution showed a small but definite maximum in the high energy region (at about 27 Mev), which was not present at the smaller angles. This peak is ascribed to the ^{4}He(p,d)^{3}He reaction and is regarded as indicating the

presence in the ^{4}He nucleus of nucleons with momenta of the order of 1000 Mev/c. (ATD)

27484 KNOCK-OUT OF α PARTICLES FROM LITHIUM, OXYGEN AND NITROGEN NUCLEI BY 660 Mev PROTONS. A. P. Zhdanov, V. N. Kuz'min, and R. M. Yakovlev. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 239-41 (Feb. 1965). (In Russian)

Direct knock-out of α particles from Li, O, and N by protons was investigated with a 660-Mev proton beam. The reaction products were recorded with nuclear emulsions, and doubly charged tracks were counted at angles of 79.5, 77.5, and 75.5°. Correction was made for doubly charged compound nucleus disintegration products by subtracting the number of doubly charged tracks observed at 115°, which was found to be the same as that observed at 90 and 105°. The energy distributions of the knock-out α particles from Li and O are presented as histograms. The cross sections for direct α-particle knock-out at 77.5° were found to be 0.7, 3.2, and 2.3 mb/sterad for Li, O, and N, respectively. The cross section for Li decreased with decreasing angle, whereas that for 0 increased slightly. This difference is ascribed to participation of excited states of the residual ^{12}C nucleus in the case of oxygen. The oxygen cross sections were compared with theoretical results of Balashov, Boyarkina, and Rotter (Preprint, OIYaI P-1357, Dubna, 1963), and good agreement was found. (ATD)

27485 INTERNAL CONVERSION ELECTRONS ACCOMPANYING ALPHA DECAY OF Pu^{239} AND THE LEVEL DIAGRAM OF U^{235}. E. F. Tret'yakov and L. N. Kondrat'ev (Inst. of Theoretical and Experimental Physics, State Committee on Uses of Atomic Energy, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 242-8(Feb. 1965). (In Russian)

The internal conversion electrons accompanying α decay of ^{239}Pu were observed with a double toroidal-field iron-free β spectrometer. The α-e coincidence method was employed to reduce the background. The ^{239}Pu, from which Am impurities were chemically removed, was vacuum deposited on 1.5-mg/cm^2 mica sheets or aluminum foils. One-hundred-six conversion lines were observed and tabulated, and 98 of them were identified. Forty-two ^{235}U γ transitions were found and multipolarities were obtained for 27 of them. These results generally confirm those of Morri and Cline (Bull. Amer. Phys. Soc. 6: 239, 1961); only two γ rays reported by these authors, at 316 and 235 kev, were not found. A level diagram for ^{235}U was constructed on the basis of the present measurements and those of Baranov, Kulakov, and Belensky (Nucl. Phys. 41: 95, 1963). Four new levels were found, of which one level is considered doubtful. The level diagram shows the presence of 3 rotational bands, of which one can be followed through 8 levels. (ATD)

27486 THE EFFECT OF NUCLEAR STRUCTURE ON L SHELL INTERNAL CONVERSION COEFFICIENTS FOR HINDERED GAMMA TRANSITIONS. M. A. Listengarten and A. P. Feresin. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 258-65(Feb. 1965). (In Russian)

Formulas are derived for calculating internal conversion coefficients using different nuclear models without repeating calculations of electronic radial wave function integrals. In these formulas the contributions of the nuclear convection currents and spin currents, for which the asymptotic selection rules differ, are kept separate. These formulas are employed to analyze the L-shell internal conversion anomalies of the ^{231}Pa 82.4-kev, the ^{237}Np 26.4-kev, and the ^{237}Np 60-kev transitions and to determine the relative contributions of the different nuclear processes. The results obtained for the ^{231}Pa transition agree with those of Church and Weneser, although these authors did not take into account the ordinary conversion matrix elements. This agreement is ascribed to the large magnitude of the anomaly. The formulas were also employed to calculate the difference between the L shell internal conversion coefficients predicted by the nonpenetrating electron model of Rose and the surface current model of Sliv. Except for some M1 transitions, this difference was found to be the order of 1% and thus insufficient to explain the difference between the internal conversion coefficient tables of Sliv and Band and those of Rose. The formulas derived can also be used to calculate the influence of nuclear structure on the angular correlation of conversion electrons. (ATD)

27487 ON DETERMINING MULTIPOLARITY MIXTURES BY THE INTERNAL CONVERSION METHOD. I. M. Band. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 266-7 (Feb. 1965). (In Russian)

It is pointed out that tables of internal conversion coefficients are not computed with absolute accuracy and interpolation errors are involved in their use. In the tables of Sliv and Band, the L-shell entries may be in error by as much as 2% and, considering also the possible interpolation error, discrepancies as large as 5-6% can be involved. Discrepancies greater than experimental error between the E2 admixtures indicated by L_I/L_{II} and L_I/L_{III} ratios for several Eu, Lu, and Bk transitions, found by Novakov, Hollander, and Graham, and ascribed by them to structure effects (even though the transitions are not highly forbidden), are well within the possible errors involved in the use of the tables and do not require the assumption that such structure effects are present. (ATD)

27488 ANGULAR CORRELATIONS OF CONVERSION ELECTRONS. I. M. Band and M. A. Listengarten. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 268-76(Feb. 1965). (In Russian)

The parameter b_2 in the conversion electron correlation function, tabulated for K-conversion by Biedenharn and Rose (Revs. Mod. Phys. 85: 5, 1952), was calculated for L_I and L_{II} conversion with the aid of the matrix elements of Band, Listengarten, and Sliv, and the results are presented graphically. For the calculations an error of sign in the work of Biedenharn and Rose was corrected and the effects of screening and finite nuclear radius were taken into account. The curves presented show the dependence of b_2 on transition energy for K, L_I, and L_{II} conversion of M1, E1, E2, and M1 + E2 transitions. Data for K conversion are given for atomic numbers from 81 to 92 and data for L conversion for atomic numbers from 73 to 98. The K conversion calculations show that the effect of screening and finite nuclear size is to increase the values of b_2 for M1 transitions by 20 to 40% over the values given by Biedenharn and Rose. (ATD)

27489 NEUTRON-PROTON INTERACTION ENERGY FROM EXPERIMENTAL NUCLEAR MASS VALUES. G. F. Dranitsyna and V. M. Mikhailov. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 277-87(Feb. 1965). (In Russian)

A study is made of the interaction energy between the odd neutron and proton in an odd-odd nucleus and the center of gravity of the multiplet to which the ground state belongs. Two linear functions of the masses of the eight neighboring nuclei are defined, closely associated with the proton-neutron interaction energy and the multiplet splitting, respectively. The validity of these functions as measures of the energy and splitting is discussed in terms of the Hartree-Fock approximation and various corrections to it, and it is concluded that although these functions only roughly approximate the interaction energy and multiplet splitting in individual nuclei, they correctly reflect the variation of these quantities with mass number. The values of the two mass functions for odd-odd nuclei are plotted against mass number and against neutron excess, and the resulting curves are discussed. The decrease of both functions with increasing mass number is regarded as a direct consequence of the increasing nuclear radius. The centers of gravity of the ground state multiplets of the eleven odd-odd nuclei for which the requisite energy level data are available are tabulated and compared with the corresponding values calculated from the masses of neighboring nuclei. The agreement shown in this table is definitely better than could be expected on the basis of chance alone, and for six of the nuclei the discrepancy is within the sometimes very large experimental error. (ATD)

27490 BREMSSTRAHLUNG OF NONPOLARIZED ELECTRONS IN THE FIELD OF A NUCLEUS POSSESSING A MAGNETIC MOMENT. B. K. Kerimov and I. M. Abutalybov (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 288-93(Feb. 1965). (In Russian)

The differential cross section was calculated for the emission of polarized bremsstrahlung by a nonpolarized electron beam in the field of a point nucleus possessing a magnetic moment. The calculation was performed in the Born approximation, and the results are given. The presented formula represents a generalization of the Bethe-Heitler formula to the case of polarized bremsstrahlung and a target nucleus with an oriented magnetic moment. The influence of the nuclear magnetic moment is particularly great in the case of backward bremsstrahlung from high energy electrons on a light target nucleus. In the case of 1-Bev electrons on an oriented ^{7}Li target, the cross section for emission of bremsstrahlung at 180° exceeds the Bethe-Heitler value by a factor 5. This effect may find application both to the production of high energy beams of circularly polarized γ rays and to the measurement of nuclear magnetic moments. (ATD)

27491 COUPLING BETWEEN SINGLE-PARTICLE STATES AND ROTATION IN DEFORMED ODD-A NUCLEI. B. L. Birbrair and V. V. Feifrlik. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 294-301(Feb. 1965). (In Russian)

The effects of Coriolis interaction between nuclear rotation and single-particle (quasiparticle) excitations in an odd-A deformed nucleus are calculated on the basis of the superfluid nuclear model, taking Cooper pairing into account. Coriolis interaction leads to coupling of Ω bands with $\Omega \pm 1$ bands, and superfluidity makes possible an exchange of excitation with the condensate, which leads to new terms in the Green's function. Rotation also gives rise to a change in the pairing, but this effect is small and is neglected. The Green's function is calculated, and the result is discussed for the case of an isolated $\Omega = \frac{1}{2}$ band and for that of close $\Omega = \frac{1}{2}$ and $\Omega = \frac{3}{2}$ bands. The latter case is of interest in connection with ^{183}W. Taking superfluidity into account leads to a renormalization of the decoupling constant and to the appearance of irregular terms in the energy, which become important for large angular momenta. The irregular terms are negligible except at angular momenta greater than those that have yet been observed in ^{183}W. A perturbation treatment is given, based on the smallness of the Coriolis interaction matrix elements compared with the level spacing, and the results are discussed for the two cases of the mixing of one or two $\Omega = \frac{1}{2}$ bands with an $\Omega = \frac{3}{2}$ band. The theory gives the correct sign and about 10% of the magnitude for the irregular energy term in the rotational band of ^{159}Tb, whereas even the sign is incorrectly calculated when superfluidity is neglected. The effects of Coriolis interaction and superfluidity on γ transitions is discussed briefly. (ATD)

27492 DETERMINATION OF THE L-FLUORESCENCE YIELD OF MANGANESE 55 BY RADIOACTIVE DECAY OF IRON 55. A. A. Konstantinov and T. E. Sazonova. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 302-3(Feb. 1965). (In Russian)

A proportional 4π counter was used to determine the L-fluorescence yield of ^{55}Mn. Results are given for ^{55}Mn and for the L-fluorescence yields of ^{71}Ga, ^{65}Cu, and ^{51}V determined previously. Since the fluorescence yields were determined during radioactive decay (electron capture), the yield values are the average values for the whole L-shell. Average values of fluorescence yields calculated from the semi-empirical relation of Lay, $(\bar{\omega}_L/1-\bar{\omega}_L)^{1/4} = A + BZ$, with the constants A and B set equal to 0.065 and 0.007, respectively, are shown. (ATD)

27493 MÖSSBAUER LINE BROADENING IN SnO_2. Rolfe H. Herber (Rutgers State Univ., New Brunswick, N. J.) and John Spijkerman. J. Chem. Phys., 42: 4312-14(June 15, 1965).

Definite evidence for quadrupole splitting was found in the Mössbauer spectra of ^{119}Sn-enriched SnO_2. Possible origins of the observed hyperfine structure were considered. Twinning in crystal growth resulted in a somewhat distorted charge distribution and thus a nonvanishing efg tensor, which gave rise to quadrupole splitting in the resultant Mössbauer spectrum. (M.C.G.)

27494 A NEW ISOMER OF BROMINE: ^{82m}Br. J. F. Emery (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 27: 903-6(May 1965). (ORNL-P-303)

The decays of ^{82m}Br were studied by γ scintillation spectroscopy and a beta proportional counter. The new isomer was observed to decay with a half life of 6.20 ± 0.05 min, exciting a highly converted γ-ray transition in ^{82}Br of 46 ± 2 kev. α_K is 268. A total combined beta branching of 2.4% was also observed. The thermal neutron activation cross section and resonance integral for ^{82m}Br are 3.0 and 34 barns, respectively, and the corresponding values for the total production of ^{82}Br are 3.23 ± 0.2 and 41.3 ± 1 barns. (auth)

27495 RADIOISOTOPES OF IODINE AND XENON OF MASSES 120 AND 121. F. D. S. Butement and S. M. Qaim (Univ. of Liverpool). J. Inorg. Nucl. Chem., 27: 907-17 (May 1965).

A new 43 ± 3 min ^{120}Xe was produced by spallation of I with 340 Mev protons. New values for the half lives of ^{120}I, ^{121}Xe, and ^{121}I were determined. Positron and gamma energies were measured. (auth)

27496 HALF-LIVES OF NEUTRON-DEFICIENT YTTRIUM NUCLIDES. W. J. Nieckarz, Jr. and A. A. Caretto, Jr. (Carnegie Inst. of Tech., Pittsburgh). J. Inorg. Nucl. Chem., 27: 919-25(May 1965).

The neutron deficient yttrium nuclides, ^{85}Y, ^{85m}Y, and ^{83}Y were produced by spallation of yttrium oxide with 400 Mev protons. By means of a series of timed daughter isolations the following half lives were established: ^{85}Y: 4.9 ± 0.3 hr, ^{85m}Y: 2.5 ± 0.1 hr, and ^{83}Y: 7.5 ± 0.1 mins. An upper limit of 1.5 mins was set for the half life of ^{82}Y and the same value for a possible isomer of ^{83}Y. (auth)

27497 ISOMERIC YIELD RATIOS AND FRACTIONAL CHAIN YIELDS FOR ^{117}In AND ^{117}Cd PRODUCED BY PROTON-INDUCED FISSION OF Bi, Th, AND U. E. Hageboe (Univ. of Uppsala). J. Inorg. Nucl. Chem., 27: 927-41 (May 1965).

The relative independent yields of the isomeric pair ^{117g}In–^{117m}In produced by proton-induced nuclear fission were measured as a function of energy from 15–157 Mev and target element. The high spin to low spin yield ratio is generally increasing with increasing proton energy, and below 115 Mev proton energy the three targets produce the same curve. Above this energy the ratio from uranium fission seems to level off while the other reactions do not show this effect. The ratios obtained at the lowest bombarding energies are as low or lower than known isomeric yield ratios from thermal neutron-induced fission. Comparison of the results with calculations based on statistical level density theory also show that at low proton energy the primary fission fragments are formed with a very low intrinsic angular momentum. The fractional chain yields of ^{117}In is shown to be increasing with increasing bombarding energy for all targets, and to be much larger for reactions with bismuth target than for uranium and thorium. Lastly, the cumulative high spin to low spin isomeric yield ratio for the pair ^{117m}Cd–^{117g}Cd was obtained and is increasing with increasing proton energy. (auth)

27498 RECOIL PROPERTIES OF FRAGMENTS IN 150-Mev PROTON FISSION OF URANIUM-238. I. RANGES AND KINETIC ENERGIES. V. E. Noshkin, Jr. and T. T. Sugihara (Clark Univ., Worcester, Mass.). J. Inorg. Nucl. Chem., 27: 943-58(May 1965).

Thick target-thick catcher recoil ranges are reported for 20 nuclides produced in 150 Mev proton fission of ^{238}U, of which six are shielded from β-decay by stable or long-lived parent nuclides. Ranges are converted to kinetic energies by the use of a simplified version of a universal range-energy relationship of Lindhard, Scharff and Schiøtt. The simplified relationship, which is calibrated with data from thermal-neutron fission, includes a specific dependence on the charge of the recoiling fragment. Such a charge dependence is important in analyzing the difference between the kinetic energies of isobaric and isotopic

pairs of nuclides. It was concluded that in most cases only coulombic repulsion needs to be invoked to explain the differences. However, ^{136}Cs and ^{140}La appear to have anomalously low kinetic energies which are attributed to events in which there is unusually large distortion in the complementary fragment. In general the bombarding-energy dependence of the kinetic energy can be accounted for by pre-fission neutron evaporation. Unlike thermal fission, the total kinetic energy release in 150 Mev fission appears to be independent of mass ratio. (auth)

27499 RECOIL PROPERTIES OF FRAGMENTS IN 150-Mev PROTON FISSION OF URANIUM-238. II. MOMENTUM TRANSFER AND EXCITATION ENERGY. V. E. Noshkin, Jr. and T. T. Sugihara (Clark Univ., Worcester, Mass.). J. Inorg. Nucl. Chem., 27: 959-65 (May 1965).

Kinetic-energy data for twenty product nuclides in 150 Mev proton fission of ^{238}U were analyzed in terms of a two-step model of an initial fast cascade interaction, followed by neutron evaporation and/or fission. Momentum transfer was deduced by application of Sugarman's equations in which it was assumed that the momentum component perpendicular to the beam direction is negligible. Momentum transfer was converted to excitation energy by considering the initial interaction to be equivalent to a two-body collision between an incident and stationary nucleon. Excitation energies so obtained represent the value for the average event leading to a specific product measured. The analysis was done in terms of the neutron-proton ratio of the product. It was found that essentially all of the data are consistent with fission occurring according to the unchanged-charge-distribution hypothesis. In some cases post-fission neutron evaporation must be postulated. The excitation energy averaged over observed nuclides was 68 Mev, which differed perhaps significantly from the 87 Mev estimated by Monte Carlo calculations. The discrepancy may result from errors in the method of converting momentum transfer to excitation energy. In general those nuclides formed from events involving high excitation energy also show rising excitation functions with bombarding energy. (auth)

27500 REACTIONS INDUCED IN ^{56}Fe WITH 20-68 Mev He^{2+} IONS. A. Ewart and M. Blann (Univ. of Rochester, N. Y.). J. Inorg. Nucl. Chem., 27: 967-73 (May 1965).

Excitation functions are presented for the ^{56}Fe(α,pn)^{59}Co, ^{56}Fe(α,p2n)^{57}Co, ^{56}Fe(α,p3n)^{56}Co, ^{56}Fe(α,p4n)^{55}Co, ^{56}Fe(α,3n)^{57}Ni, and ^{56}Fe(α,4n)^{56}Ni reactions induced with 46-68 Mev helium ions on 99.5% enriched ^{56}Fe, and with 20-43 Mev helium ions on natural iron targets. These excitation functions were compared with the corresponding ^{59}Co(p,xpyn) excitation functions previously reported by others over the same range of excitation energies. The two sets of corresponding excitation functions agreed within experimental errors in shape and position, from the region of reaction threshold to the peaks of the excitation functions. The two sets of excitation functions also agreed in absolute cross sections up to the peaks, with the possible exception of the excitation functions for the production of ^{57}Co. At energies higher than those giving maximum yields, the proton induced reactions showed a slower decrease in yields with increased energy than the corresponding helium ion induced reactions, consistent with a greater contribution from a Serber mechanism in the proton induced reactions. The absence of a displacement between the two sets of excitation functions in the threshold region is qualitatively discussed with respect to the angular momentum considerations. (auth)

27501 STARS PRODUCED BY π^- MESONS AT REST: NATURE OF UNIT CHARGE BRANCHES. M. Dellagi (Faculte des Sciences, Tunis). J. Phys. (Paris), 26: 59-62(Feb. 1965). (In French)

The results are reported of multiple scattering measurements made on 209 tracks of length $\geq 1\ 100\ \mu$ at the end of their range in nuclear emulsion (constant sagitta method, Dilworth series of residual range). The chosen parameter is D, the arithmetic mean of the second differences relative to 4 times the length of the basic cell. The D distribution may be looked upon as one made up to two Gaussian distributions only, arising from the proton and deuteron contribution. The proton ratio is 1.1 ± 0.2. It is shown that the gap length distribution is different for tracks at very large or very small D; these tracks belong to distinct groups of particles. (auth)

27502 MEASUREMENT OF THE HALF LIVES OF EXCITED LEVELS OF YTTERBIUM-170, HAFNIUM-177 AND LUTETIUM-175. R. Rougny, J. J. Samueli, and A. Sarazin (Institut de Physique Nucleaire, Lyon). J. Phys. (Paris), 26: 63-5(Feb. 1965). (In French)

The half lives of the 84-kev level of ^{170}Yb, the 113- and 321-kev levels of ^{177}Hf, and the 113-kev level of ^{175}Lu were measured by a time-amplitude conversion technique. (D.C.W.)

27503 NUCLEON-NUCLEUS INTERACTIONS. Louis Rosen (Los Alamos Scientific Lab., N. Mex.), Jerome G. Beery, Alfred S. Goldhaber, and Elliot H. Auerbach. Nature, 206: 284-6(Apr. 17, 1965). (LA-DC-6892)

The spin-dependence of nuclear forces was used to obtain a set of optical model parameters that appears capable of describing many of the observable in nucleon-nucleus interactions over a large range of energy and nuclear species. The parameters were determined by first measuring and then analyzing, within the framework of an optical model, a large quantity of proton polarization data (80 angular distributions) at 14.5 and 10.5 Mev. A fast computer and automatic search routine were used to obtain, at each energy, a single set of parameters: the nuclear radius and surface diffuseness, the strength of the absorption, and the strengths of the refractive central and spin-orbit forces. The results emphasize the feasibility of describing complex nuclear phenomena by a simple model. (P.C.H.)

27504 PRODUCTION OF THE HEAVIEST ELEMENTS BY MULTIPLE NEUTRON CAPTURE. J. Milsted, P. R. Fields, and D. N. Metta (Argonne National Lab., Ill.). Nucl. Appl., 1: 136-44(Apr. 1965).

Calculations were made showing the buildup of higher nuclides in samples of various heavy-element starting materials at neutron fluxes ranging from 4×10^{13} to 1×10^{16}n/(cm^{2}s). Attempts were made to estimate yields of the heavier fermium isotopes and of ^{259}Md by means of the nuclear properties predicted from systematics. (auth)

27505 PRECISE ABSOLUTE INTENSITY DETERMINATION OF NEUTRON CAPTURE GAMMA RAYS. M. S. Popa and M. I. Cristu (Institute for Atomic Physics, Bucharest). Nucl. Instr. Methods, 34: 192-6(May 1965).

A suitable method of obtaining the true thermal neutron capture gamma spectrum in external beam experiments is presented. A general formula for the precise intensity calculation is then derived taking into account the 4π-emission of the gamma rays, the finite thickness of the target, the energy distribution of the thermal neutrons, and also the effect of thermal neutron scattering inside the target. Particularizations are made for cylindrical and spherical targets, the only shapes of interest as shown. (auth)

27506 SOURCE PREPARATION UTILIZING AN h.f. FIELD AND A d.c. VOLTAGE. P. Ambrosius-Olesen, O. W. Soerensen, and K. M. Bisgard (Univ. of Aarhus, Denmark). Nucl. Instr. Methods, 34: 255-7(May 1965).

The preparation of converter foils for external conversion measurements, thick sources of radioisotopes, and targets for nuclear reaction studies is discussed. A problem arises because of the often small or moderate forces between the evaporated atoms or between the evaporated layer and the backing material. Particularly in the case of thick layers of the order of 100 μg/cm^2 or above, it can be difficult to prevent the layer from peeling off the backing material. A method for minimizing this problem is outlined. The improvement is obtained by ionizing the evaporated atoms and applying a d-c voltage so that the ions penetrate into the receiving material. (C.E.S.)

27507 THE $Au^{197}(n,\gamma)Au^{198}$ CROSS SECTION FROM 13 kev TO 683 kev. K. K. Harris (Lockheed Missiles and Space Co., Palo Alto, Calif.), H. A. Grench, R. G. Johnson,

F. J. Vaughn, J. H. Ferziger, and R. Sher. Nucl. Phys., 69: 37-48(July 1965).

Cross sections for the $^{197}Au(n,\gamma)^{198}Au$ reaction were measured with an average absolute uncertainty of 4.7% and an average relative uncertainty of 3.5% at 14 neutron energies in the range from 13 to 683 kev. The $^{51}V(p,n)^{51}Cr$ reaction was used as a neutron source in these measurements. An 0.013 cm thick spherical shell of gold was irradiated at each energy by neutrons produced by proton bombardment of a thin vanadium target placed at the center of the spherical shell. The neutron flux was determined by counting the ^{51}Cr activity in the vanadium target and the number of capture interactions in the gold was found by counting the ^{198}Au activity. Both activities were measured with a calibrated 10.2 cm × 10.2 cm NaI scintillation spectrometer. The neutron energy resolution, caused principally by the target thickness and the kinematic energy spread over the sphere, increased with energy from about 10 kev (half the total neutron energy spread) at a neutron energy of 13 kev to about 74 kev at the highest energy point. As a check on the results obtained with neutrons produced by the $^{51}V(p,n)^{51}Cr$ reaction, one cross section measurement was made at a neutron energy of 39 kev with the $^{63}Cu(p,n)^{65}Zn$ reaction as the neutron source. (auth)

27508 A STUDY OF THE $Li^7(He^3,n)B^9$ REACTION BY TIME-OF-FLIGHT TECHNIQUES. Frank S. Dietrich (California Inst. of Tech., Pasadena). Nucl. Phys., 69: 49-67(July 1965).

The $^7Li(^3He,n)^9B$ reaction was investigated at incident energies from 5.2 to 12.5 Mev, using a pulsed-beam time-of-flight spectrometer in conjunction with the ONR-CIT tandem accelerator. The spectrometer includes a pre-acceleration beam-bunching system, which increases the average target current by a factor of approximately 10 for protons and deuterons, 4 and for ^3He and alpha beams. Previously unreported ^9B levels were found at excitation energies of 12.06 ± 0.06, 14.01 ± 0.07, 14.670 ± 0.016, and 16.024 ± 0.025 Mev, with widths of 800 ± 200, 390 ± 110, <45, and 180 ± 16 kev, respectively. At 12.5 Mev bombarding energy, covering the range of excitation of ^9B up to 17.9 Mev, two additional neutron groups corresponding to known ^9B states at 17.19 and 17.63 Mev were observed. The neutron groups were superimposed on an intense background continuum, attributable to processes leading to the final configuration $2\alpha + p + n$. An angular distribution at 8.7 Mev incident energy, of the neutrons leading to the 14.67-Mev state, is roughly isotropic in the center-of-mass system, and the total cross section is 8 mb. A $T = \frac{3}{2}$ assignment for the 14.67-Mev state is suggested by its narrow width, and by recent studies of the $^7Li(t,p)^9Li$ and $^7Li(^3He,p)^9Be$ reactions. A comparison of the $^7Li(^3He,p)^9Be$ and $^7Li(^3He,n)^9B$ reactions shows that the cross sections for formation of the 14.67-Mev ^9B state and the analogous ^9Be state are approximately equal, if barrier-penetration effects in the outgoing channels are removed. (auth)

27509 GRAPHIC METHOD IN SHELL MODEL OF NUCLEI. F. Doenau and G. Flach (Zentralinstitut fur Kernforschung, Rossendorf, Ger.). Nucl. Phys., 69: 68-80(July 1965). (In German)

A new graphical method for performing calculations in the shell model of nuclei is presented. Using the graphical technique of Levinson et al., important operators of the shell model were represented in a graphical manner, and their algebraic properties were described. (auth)

27510 INELASTIC SCATTERING OF 185 Mev PROTONS FROM LIGHT NUCLEI. D. Hasselgren, P. U. Renberg, O. Sundberg, and G. Tibell (Uppsala Univ.). Nucl. Phys., 69: 81-102(July 1965).

Differential cross sections were measured for scattering of 185-Mev protons from excited levels of the seven light nuclei ^6Li, ^7Li, ^9Be, ^{10}B, ^{11}B, ^{12}C, and ^{16}O. The energy analysis of the inelastically scattered protons was performed in a magnetic spectrometer giving a resolution of 0.4–0.5 Mev (full width at half maximum) of peaks in the energy spectra. The measurements cover an angular region of 3.5–45.5° in the laboratory system and excitation energies up to 30 Mev. For 31 peaks in the energy spectra angular distributions are presented. Excitation energies and in some cases intrinsic widths are given for a total of 68 levels excited in this experiment. The results are compared with those of previous experiments using incoming protons of about the same energy and, in a few cases, with theoretical analyses of inelastic proton scattering. (auth)

27511 THE POLARIZATION OF THE NEUTRONS FROM THE $N^{14}(d,n_0)O^{15}$ REACTION. F. W. Buesser, J. Christiansen, F. Niebergall, and G. Soehngen (Institut fur Experimentalphysik, Hamburg). Nucl. Phys., 69: 103-12 (July 1965).

The angular distribution of the polarization of the neutrons from the $^{14}N(d,n_0)^{15}O$ reaction was investigated at deuteron bombarding energies of 1.65, 2.05, 2.50, and 2.90 Mev. The asymmetry of the neutrons scattered by helium was measured using a parallel-plate counter telescope. The polarization was determined from the asymmetry values by means of Seagrave's phase shifts for $n-\alpha$ scattering. The experimental results show a large variation of the polarization as a function of energy. The irregularity in the excitation function at a bombarding energy of 1.90 Mev as reported by Elwyn et al. was also found in the polarization curves. (auth)

27512 RESONANCES NEAR THRESHOLD AND S-MATRIX THEORY. Hans A. Weidenmueller (California Inst. of Tech., Pasadena). Nucl. Phys., 69: 113-30(July 1965).

Threshold effects on nuclear reaction cross sections are re-examined in the frame of S-matrix theory. The Thomas-Ehrmann shift is rederived. The behavior of poles of the S-matrix near thresholds, their distribution on the sheets of the Riemann surface, and their influence on nuclear cross sections are investigated. The possibility of the occurrence of threshold states and of virtual states is discussed. The effect of the large number of thresholds encountered in the investigation of statistical fluctuations of nuclear cross sections on the average width Γ of the compound nucleus is found to be negligible. (auth)

27513 DECAY OF ^{194}Os. Noah R. Johnson (Oak Ridge National Lab., Tenn.) and W. N. Bishop. Nucl. Phys., 69: 131-9(July 1965). (ORNL-P-961)

The ^{194}Os nucleus, produced by successive (n,γ) reactions on ^{192}Os, was found to decay with a half life of 6.0 ± 0.2 y. The gamma spectrum showed a prominent transition at 43.0 ± 0.4 kev, a very weak one at 78 ± 3 kev, and the characteristic K and L x rays of iridium. No gamma-gamma coincidences were detected. A single beta group at 53 ± 4 kev was observed in the single-crystal (anthracene) measurements and in coincidence with the 43-kev gamma ray. A weak 17-kev beta-ray branch of 2% is deduced from the gamma-ray data, and an upper limit of 5% is set for any beta-ray branch going to the ^{194}Ir ground state. Two excited states in ^{194}Ir were found corresponding in energies to the gamma-ray transitions. The 43-kev state is depopulated by M1 radiation and the 78-kev state by a mixture of M1 and E2 with E2/M1 = 1.1. (auth)

27514 STUDY OF THE CONTINUOUS SPECTRA FORMED BY ALPHA PARTICLES EMITTED IN THE COURSE OF THE $^6Li + ^7Li$ AND $^6Li + ^{10}B$. A. Garin (Centre d'Etudes Nucleaires, Saclay, France), L. Marquez, and J. L. Quebert. Nucl. Phys., 69: 140-4(July 1965). (In French)

The continuous spectra of alpha particles emitted in the reactions $^6Li + ^7Li$ and $^6Li + ^{10}B$ were measured. These spectra can be quantitatively explained by a break-up mechanism. (auth)

27515 ANGULAR DISTRIBUTION OF TRITONS OF THE REACTION $^6Li(n,t)^4He$ IN THE REGION 60-100 kev. C. Beets (CEN, Mol, Belg.), G. de Leeuw-Gierts, S. de Leeuw, Y. Baudinet-Robinet, G. Robaye, and L. Winand. Nucl. Phys., 69: 145-52(July 1965).

The angular distribution of the $^6Li(n,t)^4He$ reaction for the energy region from 60 to 100 kev was studied in two experiments. In the first case the experimental setup consisted of a multiplate nuclear emulsion chamber with

a central ^{6}Li target. In the second experiment use was made of a ultra-fine grain nuclear emulsion loaded with ^{6}Li. The results show a marked asymmetry with respect to 90° in the center-of-mass system. (auth)

27516 THE (n,α), (n,p) AND (n,t) CROSS-SECTIONS AT 14.8 Mev. C. S. Khurana (Punjabi Univ., Patiala, India) and I. M. Govil. Nucl. Phys., 69: 153-7(July 1965).

The (n,α), (n,p), and (n,t) cross sections were measured with 14.8-Mev neutrons. There is a general downward trend in the measured (n,α) and (n,p) cross sections with the increase in mass number. The values were compared with the statistical theory of compound nucleus. (auth)

27517 ISOMERIC (n,2n) CROSS SECTION RATIOS AT 14.8 Mev. S. K. Mangal and C. S. Khurana (Aligarh Muslim Univ., Aligarh, India). Nucl. Phys., 69: 158-60(July 1965).

Isomeric cross section ratios at 14 Mev for the reaction (n,2n) were measured with a NaI scintillation spectrometer. Using the statistical model and the spin distribution form due to Bethe and Bloch, theoretically calculated isomeric ratios were compared with measured values to find the value for the spin distribution parameter σ. Comparison was made for the following cases: ^{198}Pt(n,2n)^{197}Pt, ^{197}Au(n,2n), and ^{82}Se(n,2n). (auth)

27518 MEASUREMENT OF X-RAY SPECTRA OF MUONIC ATOMS IN THE INTERMEDIATE REGION. J. A. Bjorkland (Argonne National Lab., Ill.), S. Raboy, C. C. Trail, R. D. Ehrlich, and R. J. Powers. Nucl. Phys., 69: 161-72(July 1965).

The energies of the 2p → 1s transition and 3d → 2p transitions in muonic atoms in the intermediate region of the periodic table were measured with a scintillation spectrometer with an anticoincidence annulus of NaI(Tl). The measurements are capable of achieving greater precision in the determination of nuclear radii than was achieved heretofore by other techniques. The results are in good agreement with similar measurements at CERN and Columbia University. (auth)

27519 THE MAGNETIC MOMENT OF THE 86.7 kev LEVEL OF Dy^{160}. S. Ofer, M. Rakavy, and E. Segal (Hebrew Univ., Jerusalem). Nucl. Phys., 69: 173-8(July 1965).

Recoilless absorption measurements of the 86.7-kev γ rays of ^{160}Dy in Dy_2O_3 isotopically enriched in ^{160}Dy and of the 25.6-kev γ rays of ^{161}Dy in Dy_2O_3 isotopically enriched in ^{161}Dy were carried out at 20°K. The absolute value of the ratio of the g factor of the 86.7 kev 2^+ level of ^{160}Dy to the g factor of the ground state of ^{161}Dy was found to be 2.02 ± 0.12. Relying on previous measurement of the magnetic moment of the ground state of ^{161}Dy, a value of 0.37 ± 0.04 was found for the g factor of the 86.7-kev rotational level of ^{160}Dy. (auth)

27520 ENERGY LEVELS OF O^{18} WITH SEPARABLE POTENTIAL. V. L. Narasimham (Panjab Univ., Chandigarh, India) and S. K. Shah. Nucl. Phys., 69: 204-8(July 1965).

Energy levels of ^{18}O were calculated for a non-local separable potential using the reaction matrix of Brueckner's theory of many-body problem. Only $2s_{\frac{1}{2}}$ and $1d_{\frac{5}{2}}$ configurations were considered. The order of the levels is in agreement with the experimental spectrum. It is suggested that an admixture of $1d_{\frac{3}{2}}$ configuration might bring the agreement between the theory and the experiment closer to one another. (auth)

27521 REACTION MECHANISM STUDY OF $l_p = 1$ STRIPPING PROCESSES ON NUCLEI OF THE 1p SHELL. I. THE REACTIONS $Be^9(d,n)B^{10}$, $B^{10}(d,n)C^{11}$ AND $B^{11}(d,n)C^{12}$. R. H. Siemssen, M. Cosack, and R. Felst (Universitat, Hamburg). Nucl. Phys., 69: 209-26(July 1965).

Angular distributions of 13 neutron groups from the reactions ^{9}Be(d,n)^{10}B, ^{10}B(d,n)^{11}C, and ^{11}B(d,n)^{12}C to the ground state and the 0.72, 1.74, 2.15, and 3.58 Mev levels of ^{10}B, to the ground state and the 2.00, 4.32, 4.81, and 6.35/6.49 Mev levels of ^{11}C, and to the ground state and the 4.43 and 7.66 Mev levels of ^{12}C were measured for at least four bombarding energies between 1.1 and 3.2 Mev. Differential yield curves were obtained at 30 and 120° for the reactions ^{9}Be(d,n)^{10}B and ^{11}B(d,n)^{12}C in steps of approximately 30 kev. Most of the measured angular distributions change slowly with bombarding energy; this indicates that the direct amplitude is still important even at low bombarding energies. A comparison with (d,p) reactions to charge conjugate states shows a close similarity in the angular distributions of the corresponding (d,n) and (d,p) reactions. (auth)

27522 REACTION MECHANISM STUDY OF $l_p = 1$ STRIPPING PROCESSES ON NUCLEI OF THE 1p SHELL. II. COMPARISON OF DIFFERENT REACTIONS. R. H. Siemssen, M. Cosack, and R. Felst (Universitat, Hamburg). Nucl. Phys., 69: 227-39(July 1965).

Angular distributions of $l_p = 1$ stripping reactions on light nuclei are compared in the energy region from 1 to 3 Mev. At 3 Mev there are three characteristic shapes which are frequently found and which differ from each other mainly at backward angles. The origin of these different shapes is not well understood. A striking similarity is further found for some transitions in the variation of the over-all shape of the angular distributions with energy. These similarities over a wide energy interval are evidently a direct interaction phenomenon. DWBA calculations show that many of the observed features of the studied angular distributions might be explained with that theory. (auth)

27523 PHOTONEUTRON PRODUCTION BY Li^6, Li^7, B^{10}, B^{11} AND O^{16}. Evans Hayward and Tannie Stovall (National Bureau of Standards, Washington, D. C.). Nucl. Phys., 69: 241-52(July 1965).

The neutron emission cross sections were measured from targets of ^{6}Li, ^{7}Li, ^{10}B, ^{11}B, and ^{16}O when they were irradiated with x rays in the energy range from 7 to almost 30 Mev. The integrated cross sections are respectively 0.40 ± 0.03, 0.49 ± 0.04, 0.44 ± 0.03, 0.42 ± 0.03 and 0.26 ± 0.02 in units of the classical dipole sum. The average cross sections for the lithium and boron targets appear to be essentially constant in the energy range 25 – 30 Mev. The data also suggest that the boron cross sections contain a great deal of structure up to the highest energies studied. (auth)

27524 EXCITATION FUNCTIONS FOR THE REACTIONS INDUCED BY ALPHA PARTICLES ON Ag^{109}. S. Fukushima (Osaka Univ.), S. Kume, H. Okamura, K. Otozai, K. Sakamoto, Y. Yoshizawa, and S. Hayashi. Nucl. Phys., 69: 273-90(July 1965).

The ^{109}Ag(α,n)^{112}In(14.4 min) and ^{112m}In(20.8 min), ^{109}Ag(α,-2n)^{111}In(2.8 d) and ^{109}Ag(α,3n)^{110}In(66 min) and ^{110m}In(4.9 h) reaction cross sections were measured up to an alpha particle energy of 40 Mev. The experimental excitation functions can be reproduced by the statistical calculation by use of a level density formula of $W_1(E) = C \exp [2\{a_1(E-\delta)\}^{\frac{1}{2}}]$ or $W_2(E) = C(E-\delta)^{-2} \exp [2\{a_2(E-\delta)\}^{\frac{1}{2}}]$, if values of a_1 between 1 and 4 Mev^{-1} or of a_2 between 4 and 7 Mev^{-1} are used and Cameron's pairing energy P is taken as −δ. It seems very likely that other reasonable choices of δ give values of the parameters a_1 or a_2 which are close to the above mentioned values. Grover's theory, which takes into account the angular momentum effect and gamma competition, is discussed. The (α,n) isomeric cross section ratios agree with the prediction of Bishop et al. The sums of the observed reaction cross sections are consistent with the capture cross sections calculated by Igo from the optical model. (auth)

27525 A STUDY OF THE REACTIONS O^{17}(He^3,α$_0$), O^{18}(He^3,α$_0$), AND O^{18}(He^3,α$_1$). M. A. Waggoner and A. A. Jaffe (Univ. of Maryland, College Park). Nucl. Phys., 69: 305-19(July 1965).

The angular distribution of the alpha particles from each of the reactions ^{17}O(^{3}He,α$_0$)^{18}O, ^{18}O(^{3}He,α$_0$)^{17}O, and ^{18}O(^{3}He,α$_1$)^{17*}O was measured over an angular range of 0−160° at thirteen values of incident energy between 2.68 and 6.47 Mev. The experimental results and a comparison of these results with the theoretical prediction of a plane-wave direct-reaction theory with two modes, pick-up and heavy particle stripping, are presented. (auth)

27526 STRONG COUPLING CALCULATION FOR THE SCATTERING OF NEUTRONS BY CARBON. F. J. Bloore

(National Research Council, Ottawa, Can. and Cambridge Univ., Eng.) and Sheila Brenner. Nucl. Phys., 69: 320-36 (July 1965).

The validity of the optical model and distorted wave approximation for the scattering of nucleons from a nucleus when the elastic and inelastic channels are strongly coupled is considered. The strong coupling method is applied to the scattering of 14-Mev neutrons from carbon and the results show that the coupling terms affect the shapes of both the elastic and inelastic differential cross sections. No systematic search for a best fit was made as the complex potential used contains no spin-orbit term. A good fit to the data was obtained at forward angles and the results suggest that, with a spin-orbit term included, the method could yield satisfactory results at all angles. (auth)

27527 RANGES OF FRAGMENTS FROM FISSION OF U^{235} WITH THERMAL NEUTRONS AND THE KINETIC ENERGY DEFICIT. N. K. Aras, M. P. Menon, and G. E. Gordon (Massachusetts Inst. of Tech., Cambridge). Nucl. Phys., 69: 337-61(July 1965). (MIT-2098-102)

Differential- and average-range measurements were made on several fission-product recoils in aluminum from fission of ^{235}U with thermal neutrons. The observed average ranges are, in mg/cm^2 Al: ^{99}Mo, 3.98 ± 0.02; ^{111}Ag, 3.55 ± 0.01; ^{115}Cd, 3.32 ± 0.01; ^{121}Sn, 3.18 ± 0.02; ^{125}Sn, 3.21 ± 0.01; ^{127}Sb, 3.25 ± 0.01; ^{129}Sb, 3.34; ^{140}Ba, 2.98 ± 0.01. Resolution of the range distributions, defined as full width at half maximum divided by average range, after removal of various experimental effects, runs from 10 ± 5% (^{99}Mo) to 18 ± 5% (^{115}Cd). Ranges of the fragments were converted to energies in order to determine the magnitude of the deficit in total kinetic energy release at symmetric fission, which were found to be 21 Mev. From the range-dispersion data, it is found that the dispersion in total kinetic energy release is not as great in the symmetric region as has been previously indicated by time-of-flight experiments. No indication is found that the kinetic energy deficit at symmetric fission is connected with the two-mode fission hypothesis which has been successful in explaining energetics of fission induced at higher energies. (auth)

27528 EXCITATION FUNCTIONS FOR THE FORMATION OF ^{7}Be AND ^{22}Na IN PROTON INDUCED REACTIONS ON ^{27}Al. Michiaki Furikawa (Tokyo Univ.), Sanshiro Kume, and Michitaka Ogawa. Nucl. Phys., 69: 362-8(July 1965).

Excitation functions for the formation of ^{7}Be and ^{22}Na in the interaction of ^{27}Al with protons up to E_p = 55 Mev were measured by means of radiochemical techniques. The excitation function for the ^{27}Al(p,^{7}Be) reaction was compared with that for the ^{24}Mg(α,^{7}Be) reaction measured by Lindsay et al. The cross sections for the (α,^{7}Be) reaction are larger than those for the (p,^{7}Be) reaction by a factor of ten at the same excitation energy of the compound nucleus. The excitation function for the ^{27}Al(p,αpn)^{22}Na reaction was compared with the data obtained by other investigators. (auth)

27529 NUCLEAR MATRIX ELEMENTS FOR THE β-DECAY OF Bi^{210}(RaE). Joergen Sodemann and Aage Winther (Universitet, Aarhus, Denmark and Universitet, Copenhagen). Nucl. Phys., 69: 369-83(July 1965).

The β-spectrum and electron polarization measurements are used in a new way to determine nuclear matrix elements by means of a β-theory including the radial dependence of the electron wave function inside the nucleus. The nuclear wave functions for ^{210}Po and ^{210}Bi given by Kim and Rasmussen are used to compute the same nuclear matrix elements. The results strongly support the structure of these wave functions. (auth)

27530 THE DECAY SCHEME OF Ne^{23}. H. Lancman, A. Jasinski, J. Kownacki, and J. Ludziejewski (Inst. for Nuclear Research, Polish Academy of Sciences, Swierk). Nucl. Phys., 69: 384-400(July 1965).

The decay scheme of ^{23}Ne was investigated. Two new excited states in ^{23}Na(2.405 and 2.87 Mev) were found. The spin of the 2.705-Mev state was found to be $^{7}/_{2}$. The level scheme of ^{23}Na up to 4 Mev, its ground state magnetic moment, beta and gamma transition probabilities are compared with the predictions of the collective model including the rotation-particle coupling. Using four bands with K = $^{1}/_{2}$, $^{1}/_{2}$, $^{3}/_{2}$ and $^{5}/_{2}$ relative good agreement is obtained for η = 4; μ = 0; κ = 0.08. (auth)

27531 ANALYSIS OF EXCITATION FUNCTIONS VIA THE COMPOUND STATISTICAL MODEL. ANGULAR MOMENTUM EFFECTS. R. A. Esterlund and B. D. Pate (Washington Univ., St. Louis). Nucl. Phys., 69: 401-22 (July 1965).

Data are presented for the ^{92}Mo(α,n)^{95}Ru, ^{92}Mo(α,p)^{95g}Tc, ^{92}Mo(α,p)^{95m}Tc, and ^{100}Mo(α,n)^{103}Ru excitation functions. These and some previously published data for reactions involving single particle emission were analyzed via the compound statistical model, with explicit inclusion of angular momentum effects. The values of a, the level density parameter, derived from comparison of the results of these calculations with experimental data agree with values predicted for the Fermi gas model. The values of I/I_r, the ratio of the nuclear moment of inertia to the moment of inertia of a rigid body, show deviations from the value predicted for a Fermi gas model of the nucleus, and an apparent systematic trend with the nuclear mass number. (auth)

27532 THE MEAN LIFE OF THE 210 kev $^{3}/_{2}^{-}$ STATE IN Pt^{195}. A. E. Blaugrund, Y. Dar, G. Goldring, J. Hess, and I. Piesser (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., 69: 423-32(July 1965).

The lifetime of the $^{3}/_{2}^{-}$ 210-kev level in ^{195}Pt was measured with the microwave method. An average mean life of 97 ± 7 psec was derived from the slope of the exponential decay and also from an analysis involving Fourier series expansion of the experimental data. The resulting B(M1) value of (0.032 ± 0.003) $(e\hbar/2Mc)^2$ is 0.23 times the single particle value for a $p_{^{1}/_{2}} \rightarrow p_{^{3}/_{2}}$ transition. A sampling system was constructed which analyzes directly the pulsed beam. The time duration of the beam pulses in the sampling experiment could be made shorter than 30 psec. From this an upper limit of 20 psec could be established for the intrinsic time spread of the beam pulse. (auth)

27533 THE HALF-LIVES OF Al^{26m}, Cl^{34}, Co^{54}, AND Cu^{58}. J. M. Freeman, J. H. Montague, G. Murray, and R. E. White (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Phys., 69: 433-44(July 1965).

The half lives of ^{26m}Al, ^{34}Cl, ^{54}Co, and ^{58}Cu were measured with an accuracy of about $^{1}/_{2}$%. The activities were produced using (p,n) reactions on ^{26}Mg, ^{34}S, ^{54}Fe, and ^{58}Ni, respectively, at bombarding energies close to the reaction threshold. A beam chopping technique permitted a series of short irradiations of about one half life interspersed with periods of several half lives during which the activities were counted. The values of the half lives obtained were 6.374 ± 0.016 sec for ^{26m}Al, 1.565 ± 0.007 sec for ^{34}Cl, 0.1937 ± 0.0010 sec for ^{54}Co, and 3.204 ± 0.007 sec for ^{58}Cu. (auth)

27534 EMISSION OF Li^{8} FRAGMENTS IN INTERACTIONS OF 9 Gev PROTONS WITH LEAD NUCLEI. W. Gajewskip, A. Gorichev, and N. A. Perfilov (Radium Inst., Leningrad). Nucl. Phys., 69: 445-54(July 1965).

A total of 185 hammer tracks from 9-Bev proton interactions with Pb nuclei were collected. After a careful study of possible errors the total emission frequency of ^{8}Li fragments for stars with $N_h \geqq 7$ was found to be 4.95 ± 0.68%. The energy spectrum and angular distributions were also determined, and a comparison was made with the predictions of nuclear evaporation theory. The nuclear temperature T and barrier V were found to be equal: T = 14.9 Mev and V = 9.6 Mev. The data obtained are discussed. (auth)

27535 COLLECTIVE MODEL FOR NEGATIVE PARITY STATES IN DEFORMED EVEN NUCLEI. M. G. Davidson (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Phys. 69: 455-64(July 1965).

A collective model based on the expansion of the nuclear surface in spherical harmonics of order three is developed which attempts to explain properties of low lying negative parity levels in even nuclei. This model is analogous to the asymmetric rotator model developed earlier for positive parity states and extended later to include negative parity states. Both rotation and vibration of the nucleus are considered in a formalism which utilizes adjustable hydrodynamic moments of inertia. This model differs from the above mentioned negative parity work in that all of the possible seven degrees of freedom are retained in the parameterization where the previous model restricted the number to five. It is found that because of the added degrees of freedom, the rotational eigenfunctions no longer display the symmetry of the group D_2, which results in a considerably more complex level structure. Reduced transition probability ratios based on this model are also calculated. (auth)

27536 THE DECAY OF 0.3 SEC Ba^{136m}. F. Ruddy and B. D. Pate (Washington Univ., St. Louis). Nucl. Phys., 69: 471-6(July 1965). (TID-21750)

A radioactivity with a measured half life of 0.37 ± 0.05 sec was chemically separated from specimens of 12.9 d ^{136}Cs and was found to be associated with prominent gamma rays of energies 164 ± 5, 818 ± 10, and 1053 ± 10 kev. These data are consistent with the activity being due to the decay of the 2035 kev metastable level in ^{136}Ba, postulated in a previously published decay scheme for ^{136}Cs. (auth)

27537 A SEARCH FOR WEAK TRANSITIONS IN THE DECAY OF Eu^{152}. Toshio Katoh and E. H. Spejewski (Indiana Univ., Bloomington). Nucl. Phys., 69: 477-80 (July 1965).

Weak internal conversion electron in the decay of ^{152}Eu were investigated by a semiconductor spectrometer and a magnetic spectrometer. The K lines of the 658, 720, and 767 kev transitions were observed. (auth)

27538 LEVEL SEPARATION CORRECTIONS TO RESONANCE INTEGRALS. Harvey J. Amster (Univ. of California, Berkeley). Nucl. Sci. Eng., 22: 267-9(1965).

The use of the Wigner formula for infinite homogeneous media for calculating resonance escape probability is discussed. Large level spacings are required by the Wigner formula for nonhydrogenous moderators because the flux immediately above each resonance is assumed to be of the form 1/E. However, when the spacings are not very large, a resonance may lie in the midst of Placzek oscillations produced by other resonances at higher energies. Then there arises the problem of determining how the resonance absorption in Placzek oscillations affects the flux below the resonance. This problem is treated by considering each resonance as a negative monoenergetic source equal to its absorption rate. (C.E.S.)

27539 A STATUS REPORT: UNDERSTANDING THE FISSION PROCESS. R. Hobart Ellis, Jr. (International Atomic Energy Agency, Vienna). Nucleonics, 23: No. 5, 78; 80-2; 87(May 1965).

Some research on fission is reviewed, with emphasis on the experimental techniques. Investigations of symmetry in fission, fission of nuclides not generally considered to be fissionable, and charge and mass distributions are included. (D.C.W.)

27540 ON THE ASYMPTOTIC APPROXIMATION FOR THE ELASTIC SCATTERING BY A POTENTIAL. I. MONOTONIC POTENTIAL AND UNCRITICAL RANGE. P. C. Sabatier (Universite de Paris, Orsay, France). Nuovo Cimento (10), 37: 1180-1227(June 1, 1965).

The set of approximations usually known as the semiclassical description of scattering is developed in such a way that the next orders in the asymptotic expansions may be calculated. An additional approximation enables one to treat the effects of surface potentials and, in particular, spin-orbit potentials. In order to avoid nonessential difficulties, the derivation is done for monotonic potentials and energies above the critical energy. It is shown that the JWKB phase-shift considered as a function $\delta(p)$ of the classical angular momentum may be written as the fractional integral of a function associated to the potential and reducing to it for very large energies. One infers from this that the cosine Fourier transform of $\exp[2i\delta(p)]$ is negligible beyond π for an analytic potential and this suggests a method to transform the discrete Faxen-Holtzmark expansion into an integral. A failure of this scheme occurs near a singularity like the critical point and gives rise to oscillations which may be the most important term at large angles. Applications of the semi-classical analysis are given for the study of interference oscillations in the cross section and polarization curves of neutron-nucleus scattering. The legitimacy of the JWKB phase-shift is questioned. Careful methods are given to make an evaluation of the neglected terms and it is shown that in the neighborhood of the critical point, the Born approximation fails for this evaluation. Even for energies well above the critical energy, the corrections to the JWKB phase-shift may be important at large angles, and some approximate formulas are given for their evaluation. (auth)

27541 STOPPING CROSS SECTIONS OF SOME HYDROCARBON GASES FOR 40-200-kev HELIUM IONS. John T. Park (Univ. of Nebraska, Lincoln). Phys. Rev., 138: A1317-21(May 31, 1965). (COO-35-76)

The stopping cross sections of air, CH_4, C_2H_2, C_2H_4, C_3H_8, $(CH_2)_3$, and C_3H_6 were measured for incident helium ions in the energy range 40 to 200 kev. The data are in good agreement with previous experiment work, and have standard deviations between 2 and 6%. They obey an energy dependence $\epsilon = \beta E^{1/2}$ in accord with the calculation of Lindhard and Scharff. It has been shown that while there is probably an effect due to chemical binding on the helium-ion stopping cross sections of hydrocarbons, this effect is small. (auth)

27542 MEASUREMENT OF HYPERFINE STRUCTURE OF THE J = 3, K = 2 INVERSION LINE OF $N^{14}H_3$. S. G. Kukolich (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 138: A1322-5(May 31, 1965).

The magnetic hyperfine structure of the J = 3, K = 2 inversion line of $^{14}NH_3$ was measured in a maser spectrometer employing the method of separated oscillating fields. The molecular-resonance line-width of this system is 350 cps at 23 kMc. The measured frequencies of the 3-2 inversion-line components are (in cycles/sec): 22 834 247 980 ± 50, 22 834 209 990 ± 50, 22 834 207 230 ± 50, 22 834 185 130 ± 20, 22 834 163 020 ± 50, 22 834 160 270 ± 50, 22 834 122 270 ± 50. The pairs of lines adjacent to the main line were unresolved previously. (auth)

27543 ELECTRON SLOWING-DOWN SPECTRUM IN Cu OF BETA RAYS FROM ^{64}Cu. W. J. McConnell, H. H. Hubbell, Jr., R. N. Hamm, R. H. Ritchie, and R. D. Birkhoff (Oak Ridge National Lab., Tenn.). Phys. Rev., 138: A1377-83(May 31, 1965). (ORNL-P-942)

The electron slowing-down spectrum of ^{64}Cu beta rays in an effectively infinite isotropic copper medium was measured from 56 kev to 11 ev above the bottom of the conduction band with a spherical electrostatic electron spectrometer utilizing a Faraday cup and an electrometer as detector. The black-body cavity source was in the shape of two parallel coaxial disks of radioactive copper. Electrons emerged into the spectrometer through the opening between the disks. The flux varied from about 2.2×10^{-6} electrons cm^{-2} eV^{-1} per primary beta-ray cm^{-3} at 56 kev to 3.4×10^{-4} at the peak of the secondary-electron maximum at 15 ev above the bottom of the conduction band. A step at about 7 kev is identified as the sum of the Ni KLL Auger electrons caused by electron capture in ^{64}Cu, Cu KLL Auger electrons from the filling of K vacancies in copper atoms ionized by beta rays, and photoelectrons produced by K_α x-rays from both Ni and Cu. Less prominent steps at 800 and 250 ev are probably LMM Auger electrons and L_α photoelectrons, and the Compton edge from K_α x rays, respectively. The spectrum was compared above 35 ev with our extension of the Spencer-Attix continuous slowing-down theory and above 1.8 kev with the tabulation of the Spencer-Fano theory by McGinnies. Agreement with both theories was found everywhere within experimental uncertainties. (auth)

27544 DECAY OF Pd^{100} TO ODD-ODD Rh^{100}. J. S. Evans and R. A. Naumann (Princeton Univ., N. J.). Phys. Rev., 138: B1017-23(June 7, 1965). (PPAD-2137-535)

The gamma and conversion-electron spectra accompanying the decay of 4.0-day ^{100}Pd were studied using a lithium-drifted germanium detector, permanent-magnet spectrographs, and an orange beta-ray spectrometer. Strong transitions with indicated multipolarities were found at 32.72 (M1 + E2), 42.10 (E1), 74.77 (E1), 84.00 (M1), and 126.07 (E1) kev; weaker transitions were observed at 55.82, 139.72, 151.55, and 158.77 (E1) kev. The level scheme of odd-odd ^{100}Rh was elucidated, using conversion electron-γ-ray coincidence measurements. Levels in ^{100}Rh are indicated at 0 (1−), 32.70 (2−), 74.79 (2+), 158.77 (1+), and 214.6 (+) kev. Delayed-coincidence events were observed between the strong 74.77- and 84.00-kev transitions, indicating a lifetime of 0.18 ± 0.02 μsec for the 74.79-kev level in ^{100}Rh. It is suggested that two different proton configurations $(g_{9/2})^5$ and $(g_{9/2})^4p_{1/2}$ contribute to the positive- and negative-parity ^{100}Rh states, respectively. Proton and neutron shell-model configurations are suggested for several levels. A jj-coupling model is used to interpret the spins and parities of the observed levels. (auth)

27545 ELECTROMAGNETIC DECAY OF NUCLEI WITH HIGH ANGULAR MOMENTA ACCORDING TO THE LIQUID-DROP MODEL. Daniel Sperber (Illinois Inst. of Tech., Chicago). Phys. Rev., 138: B1024-7(June 7, 1965). (IITRI-A6034-2(App.II))

The spectrum and the angular distribution of gamma rays from deformed liquid-drop nuclei are calculated. It is shown that the angular distribution changes when the equilibrium shapes change from oblate spheroids rotating about the minor axis to prolate spheroids rotating around one of their minor axes. (auth)

27546 NUCLEAR STATES WITH HIGH ANGULAR MOMENTA ACCORDING TO THE SINGLE-PARTICLE MODEL. Daniel Sperber (Illinois Inst. of Tech., Chicago). Phys. Rev., 138: B1028-35(June 7, 1965).

An expression for the minimum rotational energy of a nucleus is obtained assuming that any observable quantity may be represented by a sum of contributions from the individual nucleons. The expression is evaluated explicitly using the Fermi-gas model with two different potentials, and using the shell model. Computation of selected effective moments of inertia indicate that the moment of inertia of the nucleus is of the same order of magnitude as that of a rigid body. (auth)

27547 AXIALLY ASYMMETRIC REGIONS IN THE s-d SHELL. J. Bar-Touv (Weizmann Inst. of Science, Rehovoth, Israel) and I. Kelson. Phys. Rev., 138: B1035-41(June 7, 1965).

The Hartree-Fock problem for even-even nuclei in the s-d shell is solved without requiring the intrinsic state to be axially symmetric. Two regions of axial asymmetry are found—around ^{24}Mg and around ^{32}S. The existence of an energy gap between occupied and nonoccupied single-particle states is established for all cases. The moment-of-inertia tensor for the axially asymmetric cases is computed and provides an improvement over the axially symmetric results of former calculations. (auth)

27548 INTERNAL CONVERSION COEFFICIENTS: GENERAL FORMULATION FOR ALL SHELLS AND APPLICATION TO LOW-ENERGY TRANSITIONS. R. F. O'Connell (Louisiana State Univ., Baton Rouge) and C. O. Carroll. Phys. Rev., 138: B1042-54(June 7, 1965).

Exact analytical results (in the case of a point nucleus with no screening) for the internal conversion coefficients for any shell are presented. These results simplify considerably at threshold values of the gamma-ray energy. Numerical results, at threshold, are obtained for the K, $L(L_I, L_{II}, L_{III})$ and $M(M_I, M_{II}, M_{III}, M_{IV}, M_V)$ shells for 19 values of Z in the range $5 \leq Z \leq 95$, and for the first five electric and magnetic multipoles. The results for the K shell agree with those obtained by Spinrad. It is shown that the threshold results are actually correct to order P (momentum of electron in units of its mass). The effects of finite nuclear size are also considered. (auth)

27549 LEVELS IN ^{43}Ca AND ^{45}Ca STUDIED BY THE ^{43}Ca(d,d′), ^{46}Ca(d,d′), AND ^{46}Ca(p,p′) REACTIONS. T. A. Belotte (Massachusetts Inst. of Tech., Cambridge), J. H. Bjerregaard, Ole Hansen, and G. R. Satchler. Phys. Rev., 138: B1067-79(June 7, 1965). (ORNL-P-974)

The ^{43}Ca(d,d′) and ^{46}Ca(d,d′) reactions were studied at bombarding energies of 8.522 and 10.005 Mev, respectively. The deuterons were recorded on photographic emulsions in a multiple-gap heavy-particle spectrograph with an energy resolution of 15 kev. The measured angular distributions were analyzed using the distorted-wave theory, and probable values of the angular-momentum change involved in the excitations were determined. The absolute cross sections are compared with the predictions obtained by using shell-model wave functions as well as collective vibrational wave functions. A simple model for the deuteron-nucleus interaction is introduced. In addition to the (d,d′) experiments, the ^{46}Ca(p,p′) reaction was studied at 3.8- and 7.00-Mev bombarding energies. The energies (in Mev) of the states observed in ^{45}Ca and their assigned spins and parities are 1.347 (2^+), 2.423, 2.575, 3.023 ($2,3^+$), 3.614 (3^-), 3.645, 3.780, and 4.434 (3^-). In ^{43}Ca(d,d′) we observe levels at 0.369 ($3/2^-$), 0.595 ($3/2^-$), 1.675 ($11/2$?$^-$), 1.932 (?$^-$), 2.051 ($3/2^-$), 2.070 ($15/2$?$^-$), 2.098 ($9/2$?$^-$), and 2.252 (?$^-$) Mev. (auth)

27550 EFFECT OF DATA NORMALIZATION UPON DEUTERON OPTICAL-MODEL PARAMETERS. J. K. Dickens and F. G. Perey (Oak Ridge National Lab., Tenn.). Phys. Rev., 138: B1080-3(June 7, 1965). (ORNL-TM-970)

The sensitivity of optical-model parameters to the absolute normalization of 12-Mev deuteron elastic-scattering angular distributions from ^{60}Ni, ^{90}Zr, and ^{114}Cd was studied. Very large variations in parameters were found, particularly when the diffraction pattern of the angular distribution is not pronounced. It is concluded that very accurate absolute normalization of the data may be necessary to make meaningful optical-model analyses. Large parameter fluctuations from element to element, observed in previous deuteron optical-model analyses, are probably due to differences in normalization of the data. (auth)

27551 ELASTIC SCATTERING OF LOW-ENERGY DEUTERONS FROM ^{60}Ni AND ^{114}Cd AND THE EFFECT OF THE DEUTERON ELECTRIC POLARIZABILITY IN THE OPTICAL-MODEL POTENTIAL. J. K. Dickens and F. G. Perey (Oak Ridge National Lab., Tenn.). Phys. Rev., 138: B1083-8(June 7, 1965). (ORNL-TM-962)

Differential cross sections for elastic scattering of deuterons from ^{60}Ni and ^{114}Cd were measured for deuteron bombarding energies between 5 and 15 Mev. The data were analyzed by means of an optical model that includes a potential due to the deuteron electric polarizability. It is concluded that the effects of the polarizability are small, although not negligible, and that nuclear interactions still dominate the elastic scattering at these energies. (auth)

27552 SOME ENERGY LEVELS IN P^{30} OBSERVED IN RADIATIVE CAPTURE BY Si^{29} OF PROTONS WITH ENERGIES FROM 1420 TO 2160 kev. P. A. Phelps, E. A. Milne, and H. E. Handler (Naval Postgraduate School, Monterey, Calif.). Phys. Rev., 138: B1088-96(June 7, 1965).

The excitation function for the ^{29}Si(p,γ)^{30}P reaction was experimentally determined in the proton energy range from 1420 through 2160 kev. Unreported resonances in this reaction were identified at 1975, 2033, 2075, and 2117 kev with estimated errors of ±4 kev, corresponding to energy levels in ^{30}P at 7.49, 7.55, 7.59, and 7.63 Mev. Gamma spectra at these resonances are obscured by contaminant radiation but suggest complex decay schemes. Double angular-correlation measurements were made at the 1470-kev resonance indicating a resonance-level spin of 2+, or less probably, 2−. The level at 4.50 Mev in ^{30}P is shown to probably have a spin of 2+ or, less probably, 3+; these spin values are in disagreement with the 0+ that has been predicted for this level. (auth)

27553 DEUTERON STRIPPING ON Ca^{46} AT 10-Mev BOMBARDING ENERGY. J. H. Bjerregaard, Ole Hansen, and G. Sidenious (Universitet, Copenhagen). Phys. Rev., 138: B1097-1105(June 7, 1965).

The reaction $^{46}Ca(d,p)$ was examined at 10.129-Mev bombarding energy with an energy resolution of 15 kev. Absolute differential cross sections were measured at 24 scattering angles. The target was prepared by isotope separation to a relative purity in ^{46}Ca of more than 99%. Twenty-eight levels in ^{47}Ca up to 6.6-Mev excitation were identified. Twenty-one of the transitions could be analyzed by deuteron-stripping theory in the distorted-wave approximation to yield values of the orbital angular momentum of the transferred neutron and of the transition strength. Spin values are suggested for a number of ^{47}Ca levels, partly based on the back-angle behavior of the $l_n = 1$ transitions and partly on shell-model systematics. The data are discussed in terms of shell-model sum rules and comparisons between the present data and other data on ^{47}Ca, as well as on other N = 27 nuclei, are presented. (auth)

27554 COULOMBIC MODIFIED EFFECTIVE-RANGE THEORY FOR LONG-RANGE EFFECTIVE POTENTIALS. R. Oppenheim Berger and Larry Spruch (New York Univ., New York). Phys. Rev., 138: B1106-15(June 7, 1965).

A modified effective-range theory (MERT) was introduced previously to describe the scattering of a charged particle by a neutral polarizable system. The long-range components of the resultant effective one-body (generalized optical-model) potential, which cause the phase shift to have a rapidly varying energy dependence, are taken account of exactly by solving a one-body problem numerically. The short-range potential components generate only a slowly varying energy-dependent effect on the phase shift, and this effect can be accounted for by a few terms in a power series in k^2. The procedure is here extended to the case for which the polarizable system is itself charged. An MERT expansion is derived for the difference $\delta(k)$ between the total phase shift $\eta(k)$ and the phase shift $\rho(k)$ due to the long-range tail alone: both $\eta(k)$ and $\rho(k)$ are defined relative to pure Coulomb scattering. With the strongly energy-dependent Coulombic and other long-range effects accounted for exactly by the numerical solution of a one-body scattering problem, low-energy scattering data can be matched by the proper choice of the coefficients of just the first few terms in the MERT expansion; these terms will then determine the scattering in the (experimentally inaccessible) energy domain extending down to zero energy. For a repulsive Coulomb field, the leading term in $\eta(k)$ is determined exactly for all L by the Born approximation; for $V(r) = (2\mu/\hbar^2)(-\beta^2/r^4)$, where $\alpha = \beta^2\hbar^2/|\mu e^2 Z_1 Z_2| = \beta^2\alpha_0$ is the electric-dipole polarizability of the target, $\tan\eta(k) = \beta^2\alpha_0^2k^3/15$ for $k\alpha_0 L \ll 1$. (auth)

27555 DETERMINATION OF THE COHERENT NEUTRON SCATTERING AMPLITUDES OF BORON, NITROGEN, AND OXYGEN BY MIRROR REFLECTION. R. E. Donaldson, L. Passell, W. Bartolini, and D. Groves (Univ. of California, Livermore). Phys. Rev., 138: B1116-19(June 7, 1965). (UCRL-12270)

The coherent neutron scattering amplitudes of boron, nitrogen, and oxygen were measured by the mirror-reflection method. The measured values are $a_B = (5.40 \pm 0.04) \times 10^{-13}$ cm, $a_N = (9.19 \pm 0.11) \times 10^{-13}$ cm, and $a_0 = (5.80 \pm 0.05) \times 10^{-13}$ cm. The nitrogen and oxygen values are in agreement with previous measurements. The boron measurement is discussed with regard to the amplitudes of the separate isotopes, and evidence for a resonance in the ^{10}B scattering cross section is given. (auth)

27556 POLARIZATION OF PHOTOELECTRONS FROM MAGNETIZED NICKEL. R. L. Long, Jr. (Yale Univ., New Haven), V. W. Hughes, J. S. Greenberg, I. Ames, and R. L. Christensen. Phys. Rev., 138: A1630-5(June 14, 1965).

An experiment is described in which the polarization of photoelectrons from a magnetized nickel crystal was measured. After acceleration of the photoelectrons to 120 kev by an electrostatic accelerator, the polarization was measured by the Mott scattering technique and was found to be zero within the experimental accuracy of 2%. Possible explanations of this result, including the nature of the electron band structure and depolarizing mechanisms, are discussed. Hence, photoemission from ferromagnets does not appear to be a useful source of polarized electrons for other experiments. (auth)

27557 BOUNDARY-CONDITION CONSTRAINTS FOR THE SHELL MODEL: A METHOD FOR NUCLEAR STRUCTURE AND NUCLEAR REACTIONS. W. Tobocman and M. A. Nagarajan (Case Inst. of Tech., Cleveland). Phys. Rev., 138: B1351-5(June 21, 1965).

It is proposed that the asymptotic boundary conditions be used as constraints for shell-model calculations. Two formalisms which permit this to be done are presented. In one formalism the boundary conditions are introduced as constraints in a variational principle. In the other formalism Green's theorem is used to make the dependence on the boundary conditions explicit. The use of boundary-condition constraints permits the use of the shell-model method for scattering and reactions as well as for nuclear-structure calculations. It is suggested that the constrained-shell-model method will improve the representation of the nuclear surface and will provide the basis for a truly unified treatment of nuclear reactions. In such a unified treatment compound-nucleus resonances, direct-reaction transitions, and optical-model scattering will be generated from a single, fairly fundamental model. (auth)

27558 HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF PROMETHIUM-148 AND ERBIUM-165. Delores Ali, Isaac Maleh, and Richard Marrus (Univ. of California, Berkeley). Phys. Rev., 138: B1356-60(June 21, 1965). (UCRL-11836)

The hyperfine structure of the $^6H_{\frac{9}{2}}$ level in 5.3 day ^{148}Pm and the $^3H_6$ level in 10-h ^{165}Er were measured by atomic-beam magnetic resonance. The spins of these isotopes were verified to be $I(^{148}Pm) = 1$ and $I(^{165}Er) = \frac{5}{2}$. The electronic g factor for the $^6H_{\frac{9}{2}}$ level in ^{148}Pm is found to be $g_J = -0.8278(1)$. The nuclear moments of ^{148}Pm were calculated from the hyperfine constants and assumptions made concerning the electronic fields at the nucleus; these assumptions include a 2% correction for the breakdown of Russell-Saunders coupling, but do not include corrections for the Sternheimer effect. The stated errors include a 5% uncertainty for $\langle 1/r^3 \rangle$. The Fermi-Segrè formula and the direct measurement of the magnetic moment of ^{167}Er were used to calculate the dipole moment of ^{165}Er. The quadrupole moment of ^{165}Er was not corrected for the Sternheimer effect. The measurements indicate that ^{148}Pm may be described by the shell model, but that ^{165}Er is deformed and must be interpreted by the collective model. (auth)

27559 SPINS OF NEUTRON RESONANCES AND THE HYPERFINE COUPLING CONSTANT IN GADOLINIUM METAL. F. J. Shore, C. A. Reynolds, V. L. Sailor, and G. Brunhart (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 138: B1361-7(June 21, 1965). (BNL-8788)

The spins of several resonances in the neutron cross section of gadolinium were determined from measurements with polarized neutrons and polarized nuclei. Use was made of the difference in the statistical weighting factors to make the spin determinations absolute, i.e., independent of the sign of the nuclear hyperfine interaction or of any assumed directions. Assuming $\mu^{155}/\mu^{157} = +0.750$, the magnitude of the nuclear magnetic-hyperfine interaction is determined to be $A/k = (8.0 \pm 0.8) \times 10^{-4}$°K for ^{157}Gd and $(6.0 \pm 0.6) \times 10^{-4}$°K for ^{155}Gd. If the nuclear magnetic moment of ^{157}Gd is assumed to be −0.33 nm, a hyperfine magnetic field at the nucleus, $H_{hf} = -(3.48 + 0.34) \times 10^5$ Oe, is obtained. (auth)

27560 DECAY OF RHENIUM-187. R. L. Brodzinski and D. C. Conway (Purdue Univ., Lafayette, Ind.). Phys. Rev., 138: B1368-71(June 21, 1965).

The end-point energy for ^{187}Re was determined to be 2.62 ± 0.09 kev by use of $(C_5H_5)_2ReH$ vapor in a proportional-counter spectrometer. The ^{187}Re half life determined

from the proportional-counting experiments is $(6.6 \pm 1.3) \times 10^{10}$ year. This is identified as the β^- half life for decay to continuum states only. When this is combined with the total half life of $(4.3 \pm 0.5) \times 10^{10}$ year obtained from $^{187}Re/^{187}Os$ ratios in geologically dated minerals, the ratio of bound-state to continuum-state decays is found to be 0.5 ± 0.3. (auth)

27561 DETERMINATION OF NUCLEAR LEVEL DENSITIES AT AN EXCITATION ENERGY OF 20 Mev. H. K. Vonach (Argonne National Lab., Ill.) and J. R. Huizenga. Phys. Rev., 138: B1372-7(June 21, 1965).

The level-density ratios in ^{56}Fe and ^{60}Ni at excitation energies of approximately 10 and 20 Mev were evaluated by combining calculations based on the statistical theory of nuclear reactions and experimental measurements of level widths Γ determined from studies of cross-section fluctuations. The importance of each of the various parameters in the statistical-theory calculation was studied as a function of the spin J of the compound nucleus. Assuming a Fermi-gas model with shell and pairing-energy corrections, the evaluated level-density ratios give values of the level density parameter a of $6.7^{+0.9}_{-0.6}$ and $6.7^{+0.8}_{-1.3}$ Mev^{-1} for ^{56}Fe and ^{60}Ni, respectively. These values of a are in excellent agreement with those made at excitation energies of less than 10 Mev. Hence, within the framework of the Fermi-gas model these results give independent evidence, in addition to the evidence already discussed in the literature, that the Γ values determined from cross-section-fluctuation measurements are those characteristic of the compound nucleus. (auth)

27562 ANGULAR CORRELATION OF GAMMA RAYS IN THE DECAY OF Rb^{84}. Jan P. Roalsvig and Karl J. Casper (Western Reserve Univ., Cleveland). Phys. Rev., 138: B1378-81(June 21, 1965).

Angular-correlation measurements were made of the cascade gamma rays following the beta decay of ^{84}Rb. The results show that the spin and parity of the second excited state of ^{84}Kr is 2+. The energies of the gamma rays in this decay were also remeasured using a lithium-drifted germanium detector and are 883, 1018, and 1901 kev with errors of ±2 kev and relative intensities of 100 : 0.53 : 1.06, respectively. (auth)

27563 MEAN LIFE OF THE 2.98-Mev LEVEL OF ^{27}Al. N. A. Khan and V. K. Rasmussen (Franklin Inst., Swarthmore, Pa.). Phys. Rev., 138: B1385-90(June 21, 1965).

Nuclear-resonance-fluorescence techniques were used to measure the mean life of the 2.98-Mev level of ^{27}Al. The exciting γ radiation was obtained by bombarding a 99.999% pure Al target with 5.00-Mev protons. Assuming the spin of the level to be $^3/_2$ and the decay to be 99% directly to the ground state, self-absorption of the resonance radiation gives a width $\Gamma = 96 \times 10^{-3}$ ev. A scattering measurement gives $\Gamma = (105 \pm 15) \times 10^{-3}$ ev. The average is $\Gamma = (100 \pm 11) \times 10^{-3}$ ev, corresponding to a mean life $\tau = (6.6 \pm 0.7) \times 10^{-15}$ sec. The angular distribution for the resonance scattering was found to be $W(\theta) = 1 + (0.06 \pm 0.04)P_{2-}(\cos\theta)$, which allows values of the E2/M1 amplitude ratio $-0.36 < \delta < +0.20$ and $-2.2 < \delta < -1.1$. The latter values are considered unlikely because of the large E2 widths they imply. It was also ascertained that the 4.12-Mev level of ^{24}Mg probably decays in less than 10^{-12} sec. (auth)

27564 NEW ISOTOPE Ni^{67}. J. L. Meason and P. K. Kuroda (Univ. of Arkansas, Fayetteville). Phys. Rev., 138: B1390-3(June 21, 1965).

Irradiation of enriched ^{70}Zn samples with 14–15 Mev neutrons was found to produce a new radioactive nuclide which was assigned to ^{67}Ni. The following radiation characteristics were observed to belong to the decay of ^{67}Ni: half life, 50 ± 3 sec; beta end-point energy, 4.1 ± 0.3 Mev; gamma-ray energies 0.90 ± 0.04, 0.89 ± 0.04, and 1.26 ± 0.04 Mev, and relative intensities 100, 48 ± 6, and 44 ± 5, respectively. A partial decay scheme for ^{67}Ni is proposed. (auth)

27565 $O^{16}(\alpha,Be^8)C^{12}$ REACTION. Ronald E. Brown, J. S. Blair, D. Bodansky, N. Cue, and C. D. Kavaloski (Univ. of Washington, Seattle). Phys. Rev., 138: B1394-1411(June 21, 1965).

Measurements were made of the differential cross sections for the $^{16}O(\alpha,^8Be)^{12}C$ reactions to the ground state and to the 4.43-Mev first excited state of ^{12}C at nine bombarding energies between 35.5 and 41.9 Mev. The ^8Be nuclei (in their ground state) were identified by detecting the two breakup alpha particles in coincidence, and by imposing the energy and angular requirements for breakup into a narrow cone. The measurements extend, for the most part, from 18 to 100° (c.m.). The angular distributions display oscillatory behavior with typical separations between peaks of 15 to 20° (c.m.). Strong fluctuations in differential cross sections were observed with changes in incident energy. The ground-state and 4.43-Mev-state yields are uncorrelated, except perhaps at 35.5 Mev where both yields are particularly large. With the exclusion of the 35.5-Mev data, the cross sections integrated from 18 to 100° (c.m.) have mean values of 0.6 mb for the ground-state reaction, and 1.0 mb for the 4.43-Mev-state reaction. The existence of the observed fluctuations refutes the original expectation that simple direct interaction processes would account for the $^{16}O(\alpha,^8Be)^{12}C$ reaction. The results can be qualitatively understood in terms of the statistical theory of compound nuclear reactions, although a substantial nonstatistical component cannot be excluded. The average width of the compound nuclear states, given by the application of the statistical viewpoint to the experimental results, is 1.1 Mev. (auth)

27566 CROSS SECTIONS FOR THE $O^{16}(\gamma,\pi^+)N^{16}$ REACTION. Richard A. Meyer, William B. Walters, and John P. Hummel (Univ. of Illinois, Urbana). Phys. Rev., 138: B1421-5(June 21, 1965).

Cross sections for the $^{16}O(\gamma,\pi^+)^{16}N$ reaction were determined by measuring the ^{16}N radioactivity produced in water samples that were irradiated with bremsstrahlung of maximum energy varying from 100 to 300 Mev. The observed yields were corrected for contributions from photonuclear reactions involving the ^{17}O and ^{18}O nuclei present in the targets and for secondary reactions. The resulting cross sections reach a maximum value of 8 μb at 240 Mev. The $^{16}O(\gamma,\pi^+)^{16}N$ cross sections average about 24% of those reported previously for the $^{11}B(\gamma,\pi^-)^{11}C$ reaction. These results are in agreement with those expected from the theory outlined by Laing and Moorhouse for reactions of this type assuming surface production of pions and assuming that the transition probabilities depend much more on the total number of states available than on the specific details of the states involved. (auth)

27567 STUDY OF THE $Ca^{40}(d,p)Ca^{41}$ GROUND STATE REACTION AT $E_d = 14.3$ Mev. Sven A. Hjorth (Univ. of Pittsburgh), J. X. Saladin, and G. R. Satchler. Phys. Rev., 138: B1425-33(June 21, 1965). (ORNL-P-1176)

The proton polarization from the $^{40}Ca(d,p)^{41}Ca$ ground-state (g.s.) reaction was measured in the angular range from 15 to 90° at a mean deuteron energy of 14.3 Mev. The $^{40}Ca(d,d)^{40}Ca$ and the $^{40}Ca(d,p)^{41}Ca$ g.s. differential cross sections were determined at the same bombarding energy and within the same angular range. A preliminary analysis of the data in terms of the distorted-wave Born approximation theory is presented. Most calculations were performed in the zero-range approximation with local optical potentials, but including the effects of nonlocality in the approximation of Perey. The inclusion of finite range improved the fit to the (d,p) cross sections but had little effect on the polarization. Although a good fit to the polarization data was not obtained, it is clear that a spin-orbit term is needed in the deuteron optical potential, and furthermore, the indications are that the imaginary part of the spin-orbit potential has to be positive or zero. (auth)

27568 FISSION-FRAGMENT ANISOTROPY IN REACTIONS OF 24-Mev ^2H AND 48-Mev ^4He WITH ^{238}U. V. E. Viola, Jr., J. M. Alexander, and A. R. Trips (Univ. of California, Berkeley). Phys. Rev., 138: B1434-40(June 21, 1965). (UCRL-10686)

The angular distribution of gross and specific fission

fragments from bombardment of ^{238}U by 24-Mev ^{2}H and 48-Mev ^{4}He were measured. These data are analyzed in terms of the Bohr angular-distribution theory and the results are found to be consistent with previous interpretations based on this model. It is found that for 24-Mev ^{2}H bombardment, the anisotropy increases with increasing mass ratio of the fragments, whereas, for 48-Mev ^{4}He, the anisotropy is nearly independent of mass ratio. For values of the fissionability parameter x greater than 0.68, the experimentally derived values for the effective moment of inertia are substantially greater than the theoretical predictions of the liquid-drop model. The dependence of the effective moment of inertia on angular momentum is found to be small within the range investigated. (auth)

27569 ELASTIC SCATTERING OF 320-Mev K^+ MESONS FROM EMULSION NUCLEI COMPARED WITH THE PREDICTIONS OF THE KNOWN K^+-MESON-NUCLEON PHASE SHIFTS. G. Heymann (C.S.I.R., Pretoria). I. J. van Heerden, and D. J. Prowse. Phys. Rev., 138: B1440-3(June 21, 1965).

Exact diffuse-surface optical-model calculations were carried out to analyze the reaction and differential elastic-scattering cross sections for K^+ mesons with a mean energy of 320 Mev in nuclear emulsion. The real and imaginary nuclear-potential volume integrals per nucleon were also obtained via the forward scattering amplitude from published K^+-nucleon phase shifts, and compared with those obtained from the optical-model analysis. The agreement is satisfactory and well within the error limits. (auth)

27570 HYPERNUCLEAR SPECTROSCOPY IN THE UNITARY SYMMETRY MODEL. [PART] II. Yukio Tomozawa (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 138: B1558-60(June 21, 1965).

The unitary-symmetry classification of hypernuclear systems is discussed taking into consideration the mixing of representations due to the symmetry-breaking interactions and the Pauli principle. There is also suggested a possible relevance of the group $SU(16) \supset SU(8) \times [SU(2)]_{spin} \supset SU(3) \times [SU(2)]_{spin}$ for light hypernuclei. (auth)

27571 MESIC ATOMS. G. Backenstoss (CERN, Geneva). Physik. Verhandl. DPG (Deut. Physik. Ges.), 4: 186-97(1964). (In German)

A survey is given of the experimental and theoretical studies on the existence and properties of mesic atoms, with emphasis on the present state of the theory. The method of measurement used are described; and the meson (μ), meson (π), and meson (K) atoms are considered. (J.S.R.)

27572 OPTICAL MODEL FOR THE INTERACTION OF PARTICLES WITH ATOMIC NUCLEI. II. UNIVERSAL OPTICAL POTENTIAL. K. Gratowski (Jagiellon Univ., Krakow and Inst. of Nuclear Physics, Krakow). Postepy Fiz., 15: 631-49(1964). (In Polish)

The optical potential, presented for a number of interacting particles, includes the ordinary real and imaginary parts of the optical potential plus a spin-dependent part. The nonlocal potential of Perey and Buck is also considered. A universal optical potential is presented for protons, neutrons, deuterons, alpha particles, tritons, and ^{3}He particles. The potential in each case is determined with the use of experimental data on scattering of particles by various nuclei, both as a function of bombarding energy and atomic charge of the target nucleus. (TTT)

27573 NUCLEON TRANSFER REACTIONS IN THE INTERACTION OF NUCLEI WITH HEAVY IONS. PART A. ONE-NUCLEON-TRANSFER REACTIONS. Leon Pomorski (Inst. of Nuclear Physics, Krakow) and Jan Tys. Postepy Fiz., 15: 651-70(1964). (In Polish)

A review is presented of experimental methods and of some experimental results involving transfer reactions. By definition, these reactions involve the transfer of either one or more nucleons from bombarding ion to target ion or vice versa. For example, these may include neutron stripping reactions, proton pickup reactions, or a combination of neutron stripping and proton pickup. Both the bombarding ion and the target nucleus considered in transfer reactions are heavier than helium nuclei. The experimental methods of measuring transfer reactions include measurement of alpha, beta or gamma activation, a combination of dE/dx and E measurement with two-dimensional display to facilitate mass separation, and measurement of delayed-neutron activation. Experimental results are given for one-nucleon-transfer reactions. These results include excitation functions, angular distributions, and energy spectra of reaction products. (TTT)

27574 AN IMPROVED S-STATE WAVE FUNCTION FOR ^{6}Li. H. U. Rahman (Univ. of Southampton, Eng.). Proc. Phys. Soc. (London), 85: 653-8(Apr. 1965).

The lowest harmonic oscillator shell model wave function of ^{6}Li, ψ_0, is modified by applying the Gauss radial function $Q = \Sigma_{i<j} {}^{6}J_{ij}$ (where $J_{ij} = \exp(-r_{ij}^2/r_c^2)$ and r_c is the assumed range of nuclear forces) to it. It is shown that $\langle Q\psi_0|H|Q\psi_0\rangle / \langle Q\psi_0|Q\psi_0\rangle$ gives a better approximation to the lowest eigenvalue than $\langle\psi_0|H|\psi_0\rangle/\langle\psi_0|\psi_0\rangle$. A typical short-range, two-body central interaction which is charge symmetric and has a Gaussian radial dependence is used in the Hamiltonian to investigate the improvement in the wave function. Considerable improvement is found by this method. (auth)

27575 SHELL AND CLUSTER MODEL WAVE FUNCTIONS AND THE (p,pd) REACTION. Daphne F. Jackson and L. R. B. Elton (Battersea Coll. of Tech., London). Proc. Phys. Soc. (London), 85: 659-71(Apr. 1965).

It is shown that the use of shell model wave functions in the analysis of quasi-free scattering meets serious difficulties due to center-of-mass motion. In contrast, the formalism of the cluster model can be used to construct a suitable wave function in relative coordinates, so that the three-body final state of the quasi-free process can be treated correctly. It is also shown that neglect of antisymmetrization and core recoil can lead to misinterpretation of the data. (auth)

27576 ON THE MÖSSBAUER EFFECT. M. K. F. Wong (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 85: 723-34(Apr. 1965).

The problem of radiation coupling in the Mössbauer effect is treated quantum mechanically. A number of coupled equations are set up and solved without making any approximations. This is made possible by comparison with the dynamical theory of Ewald. A complex refractive index is obtained, which is the same as that calculated from classical theory by Hamermesh. This is independent of the thickness of the crystal. Using the same method, the effect of internal conversion on interference between Mössbauer scattering and Rayleigh scattering is investigated. It is found that internal conversion modifies the Rayleigh scattering amplitude quite considerably, but that the Mössbauer amplitude is hardly changed. The dependence of the Mössbauer scattering cross section of circularly polarized rays on the scattering angle for both split and unsplit lines is also calculated. (auth)

27577 NUCLEAR MAGNETIC RELAXATION IN NIOBIUM METAL. J. Butterworth (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Phys. Soc. (London), 85: 735-41(Apr. 1965).

The spin-lattice and transverse relaxation rates of ^{93}Nb nuclei in various samples of niobium were measured by a pulsed r-f method in the temperature range from 20 to 300°K. The rates were sample dependent. Transverse relaxation in the best sample corresponded to a near-Lorentzian line with a width of 7.5. The dipolar line width was estimated to be 7.2 gauss. The best value for the product of spin-lattice relaxation time and temperature was found to be temperature independent and equal to 0.358 ± 0.01 sec°K. This value differs from the value of 0.190 sec°K measured by Asayama and Itoh and the value of 0.132 to 0.147 sec°K predicted theoretically by Yafet and Jaccarino. The discrepancy between the new measured value and theory is discussed in the light of recent theoretical and experimental developments. It is not reduced by plausible modifications of the band structure. Enhancement of the electron specific heat by a factor of

roughly 2 to 3 due to many-body effects could account for the discrepancy. (auth)

27578 ON THE USE OF ESCAPE OF DELAYED NEUTRONS FROM A THICK WATER TARGET FOR DETERMINATION OF THE $_8O^{18}(\gamma p)_7N^{17}$ REACTION CROSS SECTION WITH GIANT RESONANCE. M. M. Dorosh, Y. E. Kostyu, and V. O. Shkoda-Ulyanov. Ukr. Fiz. Zh., 9: 1040-1(1964). (In Russian)

The delayed neutron yield for practically infinitely thick targets was calculated on the basis of the Belen'kii-Tamm theory, making use of the previously determined values of the $^{18}O(\gamma,p)^{17}N$ reaction cross section for the delayed neutrons of ^{17}N at the giant resonance range. The ^{18}O concentration in the water used for the measurements was 0.206%. The values were plotted as the neutron yield per 1 μa/sec of electron current. At a recording efficiency of 0.5%, the number of pulses per 20 sec at a γ quantum energy of 18.7 Mev reached 1.5×10^3; the statistical error was less than 3%. (TTT)

27579 REMARKS ON THE FLUCTUATION THEORY IN NUCLEAR MATTER. Zh. S. Takibaev. Vestn. Akad. Nauk Kaz. SSR, No. 1, 39-44(Jan. 1965). (In Russian)

The probability W(R) for nucleons located at a distance less than $R \sim (2-3)\hbar/2\pi Mc$) were evaluated for ^3H. The calculations were carried out according to nucleon or high-energy π-meson elastic scattering on free light nuclei (^3H, ^3He, and ^4He), in order to determine their wave functions and obtain the frequency of recoil nuclei knock out at various energies and angular intervals. The Feshbach function $\psi = N \exp\{(-\kappa/2)(r_{12} + r_{13} + r_{23})\}$ was used as the ^3H wave function, where κ was determined by the mean kinetic energy which is a function of the potential S depth parameter. Exponential shape parameter and mean value $S = 1.777$ and $\kappa = 9.149 \times 10^{12}$ cm^{-1} were used in the calculation. Prompt ^3H nucleon configuration was constructed. The probability W(R) for ^{16}O, ^{79}Br, and ^{107}Ag were tabulated for various values R. The cross sections of ^3H fragment and the fragment yield per one collision with nucleus $q_{^3H}$ were calculated using Blokhintsev formula for W(R), with the multiplier $M = Z^2$ for ^{16}O and $M = Z$ for ^{79}Br and ^{107}Ag. The estimate was made for $R = 2(\hbar/2\pi Mc) = 4.207 \times 10^{-14}$ cm which corresponds to the impinging nucleon energy of $E_{kin} = 110.39$ Mev and impinging π meson energy of $E_{kin} = 350.04$ Mev. (R.V.J.)

27580 ANALYSIS OF THE HYPERFINE STRUCTURE OF ^{151}Eu, ^{241}Am, AND SOME 3d-ELEMENTS BY MEANS OF EXCHANGE POLARIZATION. R. Winkler (Technische Universitat, Berlin). Z. Physik, 184: 433-50(1965). (In German)

It is shown how several discrepancies in the optical hfs of Eu can be understood as consequences of the exchange polarization of the inner and outer s-electrons by the spin of the half filled ($4f^7$)-subshell, an effect which should produce additional magnetic fields at the nucleus. Thus from the two different values of the electronic splitting constant a_{6s} in the two Eu-II ground states the polarization field from the 6s-shell (ΔH_{6s}) is determined to be ~ + 260 kG, and the formal splitting constant σ (≃ −3 mK) of the ($4f^7$)-subshell yields ~ − 350 kG for the field $\Delta H_{(1\ldots5)}$ from the five inner ns-shells (n = 1 . . . 5) in good agreement with the strength of the inner field obtained from recent Mössbauer effect studies. $\Delta H_{(1\ldots5)}$ is deduced to be approximately equal in all sufficiently analyzed ground and excited configurations of the neutral and ionized Eu atom ($(4f^7)$ 6s, 6p, 5d, $6s^2$ and 6s6p). Other elements with half filled subshells (Am, Mn) show similar features in their optical hfs. For Am^+ ($(5f^7)$ 7s) ~ − 2200 kG are found for the inner field ($\Delta H_{(1\ldots6)}$). For several 3d-elements it was found that the agreement between the calculated polarization fields and those following from experimental results is better than assumed so far. (auth)

27581 EXCLUSION PRINCIPLE AND NUCLEAR REACTION MECHANISM. S. Okai, Sh. Park, and K. Wildermuth (Universitat, Tubingen, Ger.). Z. Physik, 184: 451-80(1965).

Effects of the Exclusion Principle in specific reference to direct reactions are studied in detail by formulating a simple one-dimensional model in the two channel approximation. The fact that a target wavefunction can be described by different systems of cluster wavefunctions on account of the indistinguishability of nucleons is exploited to bring out the connection between the various aspects of the reaction mechanism and the forward and the backward reaction amplitudes. The coupled integro-differential equations of the model are solved by a matrix method, and an iteration method respectively for low and high energies of the incident particle in the entrance channel. The exact solution of the coupled integro-differential equations takes into account the Exclusion Principle and the effects of rescattering and target recoil. The result shows that the direct reactions are long distance or surface phenomena. Evidence is presented that this is a consequence of the Exclusion Principle. The exact result is compared with various approximate results. The latter include the cases: antisymmeterization is completely neglected; antisymmetrization is performed on the target wavefunctions only; plane wave Born approximation; distorted wave Born approximation. The result obtained by target antisymmetrization coincides with the exact result only for high energies of the incident particle. The practical use of this result obtained by use of the two equivalent cluster wavefunctions which describe the target wavefunction is discussed in connection with heavy particle stripping. (auth)

27582 THE DECAY OF 4.4 MIN-Rh^{104m}. Martin Schumacher (Universitat, Gottingen, Ger.). Z. Physik, 185: 60-72(1965). (In German)

The decay of the 4.4 min-^{104m}Rh was investigated by observing coincidences between conversion electrons and gamma quanta. The decay by a 77 kev−52 kev cascade was confirmed. In addition, a highly converted (31 ± 2) kev transition in coincidence with the known 97-kev gamma ray was found. The multipole order of this transition was determined as M3. The intensity of the 97 kev−31 kev cascade was measured as 3.3% of the intensity of the 77 kev−52 kev cascade. An indication of a 45-kev transition from the 97-kev level to the 52-kev level was found with an intensity of at most 0.1% of the intensity of the 77 kev-52 kev cascade. (auth)

27583 EXCITATION OF THE 7.66-Mev LEVEL IN CARBON-12 BY INELASTIC ELECTRON SCATTERING. F. Gudden and P. Strehl (Technische Hochschule, Darmstadt, Ger.). Z. Physik, 185: 111-22(1965). (In German)

Using the facilities of the Darmstadt electron linear accelerator the cross section for the excitation of the 7.66-Mev level in carbon-12 was measured for momentum transfers between 0.25 and 0.55 fm^{-1}. Extrapolation of the measured cross sections for vanishing momentum transfer yields a partial width for the decay to the ground state through internal pair production of $(7.3 \pm 1.3) \times 10^{-4}$ ev. The dependence of the reduced transition probability on momentum transfer is discussed and compared with theoretical predictions. (auth)

27584 FISSION CROSS SECTION MEASUREMENTS ON Pu^{239}, Pu^{241}, U^{232} AND A SEARCH FOR FISSION COMPONENTS IN Pu^{238} RESONANCES. G. D. James (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-60/15, 13p. (CONF-650301-18)

From Symposium on the Physics and Chemistry of Fission, Salzburg, Austria.

Fission cross section measurements on ^{239}Pu and ^{241}Pu were carried out from sub-thermal neutron energy to the kev region. Resonance parameters are given and errors in the average values of the cross section are discussed. The discovery of large fission components in the ^{232}U neutron resonance stimulated a search for fission components in ^{238}Pu. The results of these experiments are given. All the measurements were performed on the Harwell time-of-flight spectrometer. (auth)

27585 SOME YIELDS IN THE THERMAL AND EPI-CADMIUM NEUTRON FISSION OF Pu^{239}. I. F. Croall and H. H. Willis (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-60/27, 16p. (CONF-650301-20; AERE-R-4723)

From Symposium on the Physics and Chemistry of Fission, Salzburg, Austria.

The yields of several nuclides in the thermal and epi-cadmium neutron fission of ^{239}Pu were measured. In epi-cadmium neutron fission a decrease, relative to thermal fission, in the yields of ^{111}Ag and ^{113}Ag, that is an increased peak to valley ratio, was found. The yields of ^{77}As and ^{78}As, which represent highly unsymmetrical fission, were found to be greater in epi-cadmium neutron fission than in thermal fission. This result is shown to be inconsistent with the simple two mode of fission hypothesis. (auth)

Plasma Physics and Thermonuclear Processes

Refer also to abstract 27131.

27586 (AD-428606) RESEARCH PHENOMENA AFFECTING THE CHARACTERISTICS OF ELECTRONIC COMPONENTS. C. K. Birdsall, S. A. Colgate, A. J. Lichtenberg, and A. W. Trivelpiece (California Univ., Berkeley. Electronics Research Lab.). Nov. 30, 1963. Contract AF33(657)-7614. 24p. (N64-20115; RTD-TDR-63-4143). CFSTI.

The work described includes theoretical and experimental studies on high-temperature plasmas. The high-temperature plasma results are reported in detail first and then the published results of the two-year period are summarized. Most of the research was on electron-beam microwave-tube type projects. (D.L.C.)

27587 (AD-602871) INTERACTION OF ELECTROMAGNETIC WAVES AND CLASSICAL PLASMAS. Monthly Report No. 10. Robert Siegel (Elcon Lab., Inc., Peabody, Mass.). Apr. 15, 1964. Contract AF33(657)-11671. 6p. $1.00(CFSTI).

The most important terms in the spherical harmonic expansion are the time- and space-dependent coefficients. Expressions for these functions have been derived. The sum and difference frequency terms, being of second order, were assumed negligible. In addition, the diffusion coefficients were equated to zero on the grounds that experimental data could be obtained prior to the onset of these effects yet after the pumping pulse. Other controllable experimental parameters were established. (auth)

27588 (AD-603523) INTERACTION OF ELECTROMAGNETIC WAVES AND CLASSICAL PLASMAS. Monthly Report No. 11. Robert Siegel (Elcon Lab., Inc., Peabody, Mass.). May 15, 1964. Contract AF33(657)-11671. 9p. $1.00(CFSTI).

Emphasis was given to the physical interpretation of mathematical expressions, and to the consequent formulation of experimentally meaningful equations. Also, a generalization of the theory to the presence of three signals was made. (auth)

27589 (AD-606829) PROPAGATION OF ELECTROMAGNETIC WAVES IN AN INHOMOGENEOUS MEDIUM. Technical (Final) Report. L. G. Napolitano (Naples Univ. (Italy). Istituto di Aeronautica). Feb. 1964. Contract AF61(052)-548. 48p. (IA-115) $2.00(CFSTI).

The thermodynamics and dynamics of ionized gases, and the influence of finite ionization rates on the wave propagation through ionized gases are discussed. A non-relativistic phenomenological theory satisfying the Lorentzian invariance of thermodynamic quantities and not based on any a priori assumption for the form of the electromagnetic momentum density is developed of an arbitrary polarizable medium. The influence of finite ionization rates is dealt with by using both the one-fluid model and the Lenhert two-fluid model for the plasma. (W.L.G.)

27590 (AD-608904) THE SUPERFAST PINCH EXPERIMENT. Vernal Josephson (Space Technology Labs., Inc., Los Angeles, Calif.). Nov. 2, 1959. Contract AF04(647)-309. 30p. $2.00(CFSTI).

An assembly designed to accelerate deuterons to about 10 kev by means of a radially converging magnetic piston has been constructed and tested. Design features and operational problems encountered are reported. Samples of experimental data are included to illustrate the assembly's behavior. Specifically, the assembly operates with 300 kv on the condenser, the ringing frequency is 18 mc, and present operation uses hydrogen gas at 50μ. Both slow and fast pinches have been observed, the former being possibly thermal shock waves, and the latter being associated with inward motion of the plasma sheath. (auth)

27591 (AD-613634) PERFORMANCE CHARACTERISTICS OF A MAGNETIC ANNULAR ARC. Research Report 209. R. M. Patrick and A. M. Schneiderman (Avco-Everett Research Lab., Everett, Mass.). Mar. 1965. Contracts NAS-3-5748 and AF49(638)-659. 47p. $2.00 (CFSTI).

The magnetic annular arc is an axisymmetric Hall current plasma accelerator. Data obtained with various propellants for input powers ranging between 10 and 100 kw are given. Between specific impulses of 3000 sec and 4000 sec, thrust efficiencies in excess of 50% were achieved. The current-voltage characteristics of the magnetic annular arc were established and a qualitative explanation of their nature is presented. The overall arc voltage is shown to be a unique function of the applied bias magnetic field strength for a given propellant and magnetic field geometry. A partial theory for this effect is developed. The functional dependence of the thrust on applied bias magnetic field strength and geometry at constant input power and propellant mass flow rate is described. Data are presented on thermal efficiency obtained from heat balances and estimates are made of $\omega\tau$ and the effect of ion slip in this device. (auth)

27592 (AED-C-12-08) NUCLEAR SCIENCE LITERATURE OF THE EASTERN BLOCK COUNTRIES. PLASMA PHYSICS. Series C: Bibliographies. Benno Ensslen, comp. (Kernforschungsanlage, Julich (West Germany). May 1964. 250p. Dep.(mn).

A bibliography of 982 references in 43 subject areas of plasma physics, published by the Eastern Block countries from 1957 to 1963, is presented. An author index is included. (W.L.G.)

27593 (AFCRL-64-548) TECHNIQUES FOR TREATING FULLY IONIZED TWO-PARTICLE PLASMA EQUATIONS. Scientific Report No. 209. R. E. Hartle (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). June 1, 1964. Contract AF19(628)-4014. 116p. (AD-607196) $4.00(CFSTI).

Analytical methods for treating the Boltzmann-Maxwell or associated continuum equations for fully ionized two-particle plasma equations were developed and their uses demonstrated through specific examples. The descriptive equations were treated exactly; that is, the usual linearization approximation was not made. A time series expansion method along with the method of partial summation was applied to the cold plasma equations. More specifically, the dependent variables were expanded in time power series and the coefficients were determined as functionals of the initial functions. Partial summation was applied to groups of terms in each expansion. The result was written in a convenient form comparable to that obtained by others and from which some plasma properties were obtained. Both the time series method and the method of characteristics were applied to the Boltzmann-Maxwell system. The general time series solution was demonstrated useful through application to a plasma in a uniform magnetic field. The method of characteristics was discussed in general and also applied to the problem of a plasma in a uniform magnetic field. (auth)

27594 (AFCRL-64-610) ELECTROMAGNETIC WAVE REFLECTION FROM AN OSCILLATING, COLLISION-

FREE MAGNETO-IONIC MEDIUM. Scientific Report No. 211. O. E. H. Rydbeck (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). June 20, 1964. Contract AF19(628)-4014. 68p. (AD-606700). $3.00 (CFSTI).

A collision free or low collision magneto-ionic medium is easily perturbed by a driving or pumping wave, even of moderate power. Unless the pump wave is of the longitudinal mode it will generate longitudinal electron velocities as well as differential space charge densities. These quantities, as well as the transverse, pump field electron velocities, will affect the propagation of any (low power) signal or probing wave propagating through the medium, which now has oscillating and travelling electron velocity and electron density ripples. (auth)

27595 (AFCRL-64-813) STUDY OF COUPLING OF MAGNETOHYDRODYNAMIC WAVES TO ACOUSTIC WAVES AT A PLASMA-NEUTRAL GAS BOUNDARY. S. L. Kahalas, L. W. Parker, and D. A. McNeill (Mount Auburn Research Associates, Inc., Cambridge, Mass.). Aug. 19, 1964. Contract AF19(628)-2836. 105p. (AD-607260). $4.00(CFSTI).

The coupling between magnetohydrodynamic waves and acoustic and electromagnetic waves is considered at a sharp boundary between a plasma and a neutral gas, and the coupling between magnetohydrodynamic and plasma waves and acoustic waves is considered at a diffuse boundary. In the sharp boundary problem, the incident wave vector is arbitrary in direction and the magnetic field vector is considered either in the plane of incidence or perpendicular to it. The ratios of the amplitudes and energy in the transmitted waves (electromagnetic or acoustic) to the corresponding amplitudes and energy in the incident waves (fast and slow magnetoacoustic, pure Alfven mode) are determined. In the diffuse boundary problem, the coupled wave equations are presented for a partially ionized plasma of spatially varying composition, with collision terms, in the presence of a magnetic field. The coupling of longitudinal plasma waves to sound waves is considered in the absence of a magnetic field. (auth)

27596 (ARL-65-12) THEORETICAL RESEARCH ON THE DYNAMICS OF PLASMA RINGS. R. S. Lundgren and C. W. Chu (Minnesota Univ., Minneapolis). Oct. 22, 1964. Contract AF33(616)-7877. 9p. CFSTI.

Summaries are presented of five related papers concerned with some aspects of the large-scale motion of a current-carrying filament of plasma under the action of external and self-magnetic fields. The topics covered are: Hamilton's variational principle for a perfectly conducting plasma continuum, equation of motion of a current-carrying plasma filament, analytical solutions for the motion of a thin plasma ring in a coaxial magnetic field, motion of a magnetically confined plasma cylinder, and nonlinear wave motion in a linear pinch. (D.L.C.)

27597 (CEA-R-2758) MISE AU POINT D'UNE METHODE D'ETUDE DES PHENOMENES NON LINEAIRES DANS UN PLASMA (theses). (Development of a Method for Studying Nonlinear Phenomena in Plasma (thesis)). Alain Gonfalone (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre de Études Nucléaires). Mar. 1965. 81p. (EUR-2277.f) Dep.(mn).

The study of nonlinear phenomena resulting from the interaction of powerful electromagnetic waves with an electron gas is the basis of the best methods for measuring the frequency of electronic collisions in the ionosphere. In laboratory plasma the appearance of these phenomena is connected with a powerful critical field. A relatively low-power electromagnetic source was used to develop a simple hyperfrequency method making it possible to study these phenomena, to measure them, and to put forward an elementary interpretation. An electromagnetic wave provided by a 1 watt klystron interacts with a HF discharge (25 MHz) in the volume of a TE_{111} cavity. The tube containing the discharge and the axis of the cylindrical cavity are co-linear with a magnetic field which can attain a value such that the wave frequency is equal to the gyromagnetic frequency of the electrons. The resonance curve for the cavity, which depends on the electronic density and the frequency of collisions, becomes increasingly dissymmetric as the absorbed power increases and as the gyromagnetic frequency of the electrons approaches that of the incident wave. By studying the resonance, it is possible to calculate the proportionality coefficients relating the density and collision frequency variations with the absorbed power. The experiments were carried out by causing the following to vary separately: the incident UHF power, the initial electronic density, the pressure of the neutral ambient gas, and the axial magnetic field. The variation in the electronic density as a function of the magnetic field for a high UHF power shows a resonance of dissymmetrical form, sometimes with a sharp peak in the neighborhood of ω_H. The possibility of applying these properties to the construction of practical devices is under consideration. (auth)

27598 (CLM-R-39) DETECTION OF AN ELECTRON BEAM IN A TOROIDAL PLASMA. D. W. Atkinson and J. M. S. Schofield (Culham Lab., United Kingdom Atomic Energy Authority, Abingdon (England)). Oct. 1964. 20p. Dep.; $0.60(BIS), 3s.(HMSO).

Two methods are described for measuring the energy and flux of an electron beam which is immersed in a high density plasma in a toroidal magnetic field when the beam energy is only a few kilovolts. The first method uses an x ray technique which enables the mean energy of the beam to be measured directly provided the spread is small. The spectrum of x rays emitted from a tungsten target in the path of the beam is analyzed with two or more scintillation counters and the energy and flux calculated from previous calibrations. A sufficiently monoenergetic beam whose energy is varied over the required range, is used to calibrate the system. Total energy is measured because the determination does not depend strongly on the angle of the beam velocity to the magnetic field. The second method measures the energy of the beam along the magnetic field only. The electrons are retarded by the potential of a planar grid. Those electrons with sufficient energy to be transmitted are collected and measured. The grid potential is pulsed on for two microseconds, which gives insufficient time for it to breakdown even when operating in plasma of density 10^{14} ions/cc, yet enough to cover the microsecond duration of the beam. (auth)

27599 (EUR-CEA-FC-273) RESULTATS EXPERIMENTAUX SUR BILLE-EN-TETE "A". 1ÈRE PARTIE. COLLISIONS EN CHAMP MAGNETIQUE HOMOGÈNE. (Experimental Results on Bille-en-Tete "A". Part I. Collisions in Homogeneous Magnetic Fields). P. Evrard, J. Jacquinot, C. Leloup, J.-P. Poffe, and F. Waelbroeck (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre de Études Nucléaires). Oct. 1964. 67p. (CONF-641108-11) Dep.(mn).

From American Physical Society, New York.

Collisions of plasma puffs, whose characteristics (density and velocity) were varied in a broad domain were studied in a homogeneous longitudinal magnetic field. It was verified that the puffs met head on. It was shown that collisions of dense ($n_i \geq 4.10^{14}$ cm^{-3}) and relatively slow ($v_0 \leq 10^7$ cm. sec) puffs are "efficient," i.e. the initial kinetic energies of the puffs are converted into thermal energy of the ions in the resulting plasma. Faster and less dense puffs interact little resulting incomplete conversion of kinetic into thermal energy. The limit between efficient and inefficient collisions corresponds to that which is expected from the test particle model. The slowing down of the puffs is thus ensured mainly by particle-particle interactions. The use of electric probes and the examination of the evolution of the plasma produced by the collision show that this plasma does not exhibit any rapid radial motion. (auth)

27600 (EUR-CEA-FC-274) RESULTATS EXPERIMENTAUX SUR BILLE-EN-TETE "A". 2ÈME PARTIE. COLLISIONS EN BOUTEILLE MAGNETIQUE À MIROIR. (Experimental Results on Bille-en-Tete "A". Part II. Collisions in Magnetic Bottles in Mirrors). P. Evrard, J. Jacquinot, C. Leloup, J.-P. Poffe, and F. Waelbroeck (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses

(France). Centre de Études Nucléaires). Oct. 1964. 16p. (CONF-641108-12) Dep.(mn).

From American Physical Society, New York.

In the magnetic bottle of Bille-en-Tête A (mirror ratio 4000/2000 G), the collision of two low density puffs led to the capture of one liter of plasma with a density $n_i \approx 2.10^{13}$ cm^{-3} and an ionic temperature $T_i \approx 10^{6\circ}K$. The e-folding time of the plasma diamagnetism reached 50 to 150 μsec; no flute instabilities were detected. The T_i evolution was measured by the Döppler broadening of the 4686 Å line of the He^+ (added to the injected D^+ in the proportion of 5%) and the relative evolution of n_i by the intensity of the spectral continuum. T_i decreased rapidly, reached 5.10^5 to $10^{5\circ}K$ respectively 15 and 120 μsec after the maximum of the collision diamagnetic signal. The density increased slowly to 25% during the first 100 μsec after the collision. The presence of cold plasma beyond the mirrors of the bottle allows one to justify the energy losses (thermal conductivity) and the apparent stability of the plasma column. (auth)

27601 (IAE-674) PARAMAGNITNAYA VYSOKOCHASTOTNAYA STABILIZATSIYA I NAGREV PLAZMY ELEKTROMAGNITNYMI VOLNAMI. (Paramagnetic High-Frequency Stabilization and Heating of Plasma With Electromagnetic Waves). V. Alikaev, V. M. Glagolev, and N. S. Cheverev (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1964. 24p. Dep.(mn).

It is shown that the high-frequency field pressure on plasma in a strong longitudinal magnetic field produced paramagnetic current which eliminated convective instability. Intense electron heating was found in plasma near magnetic fields corresponding to paramagnetic and electron-cyclotron resonance. Under optimum conditions plasma pressure was about 10 times stronger than pressure of high frequency fields. The maximum electron temperature in experiments using adiabatic traps was 1000 ev at $a \sim 10^{11}$ cm^{-3}. (R.V.J.)

27602 (IPP-3/27) EXPERIMENTELLE UNTERSUCHUNG DES RADIALEN DRUCKVERLAUFS IN WASSERSTOFFLICHTBOGEN BEI UBERLAGERTEM AXIALEM MAGNETFELD. (Experimental Investigation of Radial Pressure Distribution in a Hydrogen Arc Located in an Axial Magnetic Field). H. F. Doebele (Institut fur Plasmaphysik, G.m.b.H., Garching (West Germany)). Feb. 1965. 64p. Dep.(mn).

In a cylindrically symmetric hydrogen arc discharge located in an axial magnetic field, pressure is increased in the region of electric conductivity. Measurements were made with initial pressure of 1×10^4 and 2×10^4 dynes/cm^2, with temperatures between 8,000 and 12,000°K, and with magnetic induction of 8.5 and 12.5 kΓ. A mercury manometer was connected to a small opening in the anode to measure the radial pressure distribution in the plasma. Temperatures and electron densities were determined spectroscopically. The Saha equation was found to be applicable in this case. Therefore, experimental results can be compared with theory based on the Saha equation. Excellent agreement between experiment and theory was found. (auth)

27603 (JINR-P-2043) RASPREDELENIE OTNOSITEL'NOI KONTSENTRATSII ATOMOV I IONOV PO SECHENIYU GAZONOGO RAZRYADA I VDOL NEGO V ISTOCHNIKE MNOGOZARYADNYKH IONOV. (Distribution of the Relative Concentration of Atoms and Ions Along and Across the Gas Discharge in a Heavy Ion Source). L. P. Kul'kina and A. S. Pasyuk (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1965. 19p. Dep.(mn).

The distribution of the concentrations of Ne, Ar, and Kr atoms and ions were investigated in the plasma column of an arc ion source with oscillating discharge. The optical method was used. The atom and ion distribution along the arc column has a peak near the center of the gas discharge chamber of the source. The effect of the electrode material on the atom and ion distributions along the arc column is established. The Ne ion concentration distribution across the chamber has a peak on the axis of the gas discharge filament. (auth)

27604 (JPL-TR-32-695) ANOMALOUS DIFFUSION AND INSTABILITIES OF AN ARGON PLASMA IN A STRONG MAGNETIC FIELD. Che Jen Chen (Jet Propulsion Lab., California Inst. of Tech., Pasadena). Dec. 15, 1965. Contract NAS 7-100. 13p. (N65-16552). $1.00 (CFSTI).

The rate of electron density decay with time in an argon discharge tube energized with a capacitor bank of energy up to 3,000 J is measured by using electron continuum intensity, ion current probe, and microwave techniques. The discharge tube is oriented along a magnetic field up to 30 kG. The electron temperature decay is obtained by the spectral-line intensity ratio method. The oscillation or instability in the plasma is monitored with electrostatic and magnetic probes. The coefficient of ambipolar diffusion is evaluated from the decay data obtained in the diffusion-dominated region. The data thus obtained indicate that the coefficient of ambipolar diffusion agrees with the prediction of the collision theory up to the magnetic field of about 1,000 G. Beyond 1,000 G the onset of oscillations is detected and the coefficient of diffusion is much higher than the collision-theory prediction. For B > 1,000 G, the coefficient of diffusion varies as B^{-1} and the absolute values are quite close to Bohm's. It is thought that the mechanism responsible for the anomalous diffusion is the onset of an instability in the plasma, which at low magnetic field is probably dominated by ion oscillation and at high magnetic field by the so-called universal instability. The critical field for the onset of the instability in the present experiments (pressure of gas ≈500 μ Hg) is about 1,000 G. (auth)

27605 (JPL-TR-32-707) VALID CONDITIONS FOR THE KRAMERS-UNSÖLD CONTINUUM THEORY IN A NON-EQUILIBRIUM PLASMA. Che Jen Chen (Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena). Dec. 30, 1964. Contract NAS 7-100. 5p. (NASA-CR-57527; N65-20110). $1.00(CFSTI).

The Kramers-Unsöld theory of continuum intensity for electron-ion recombination is formulated quantum mechanically. The valid conditions for the theory in a non-equilibrium plasma are deduced by using Griem's criterion for partial local thermodynamic equilibrium. The results indicate that the conditions are much less restricted than those required for the Saha equation to be valid. (auth)

27606 (JÜL-203-PP) UBER DIE PARAMETRISIERUNG DER LOGUNGEN DER VLASOV-GLEICHUNG. (The Parameterization of the Solutions of the Vlasov Equation). P. Graeff (Kernforschungsanlage, Jülich (West Germany). Institut für Plasmaphysik). Nov. 1964. 121p. Dep.(mn).

Some various physical aspects which all lead formally to the Vlasov equation are discussed. The parameterization of the Vlasov equation without magnetic field is shown. The problem of positivity is then considered. A generalization of the parameterization definition is used in a series of examples of weak solutions. The model of Bathnager, Gross, and Krook is discussed. The Vlasov equation in the weak sense is given. (J.S.R.)

27607 (LA-3260) FINITE LARMOR ORBIT STABILIZATION. B. R. Suydam (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Mar. 10, 1965. Contract W-7405-eng-36. 15p. Dep.; $1.00(CFSTI).

The theory of the stabilizing effect of finite ion Larmor radius is applied to a plasma containing several species of ions. The resulting dispersion relation shows that this effect probably stabilizes Scylla and possibly also the plasma focus. Strictly, the theory applies only to a plasma of low β and with small gradients ([grad ρ]/ρ small), thus the conclusions lack certainty. (auth)

27608 (MATT-305) BEHAVIOR OF NEUTRAL HYDROGEN AND HELIUM IN C STELLARATOR DISCHARGES. F. W. Hofmann, A. S. Bishop, and E. Hinnov (Princeton Univ., N. J. Plasma Physics Lab.). Sept. 1964. Contract AT(30-1)-1238. 23p. Dep.; $2.00(cy), 1(mn) CFSTI.

Time-resolved brightness scans of H_β and H_α light, and of He I and He II light, were made across the plasma

column of the C stellarator during ohmic heating discharges in hydrogen and helium, respectively. These scans were converted to radial distributions of the light emission by Abel's integral equation. The results are interpreted in terms of the relative importance of the competing processes of ionization by electron impact and of charge exchange. It is concluded that a substantial fraction of the inflowing H atoms enter the discharge with energies less than 0.3 ev, i.e., significantly below the most probable energy, 2 ev, of the dissociation products of H_2 or H_2^+. The helium atoms enter the discharge at or near room temperature. (auth)

27609 (MPI-PA-12(64)) ON THE EQUILIBRIUM OF A PLASMA IN A CURVED MAGNETIC FIELD IN THE PRESENCE OF ELECTRON EMITTING ENDPLATES. Guenter Grieger (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). Feb. 1964. 31p. Dep.(mn).

Classical criteria for equilibrium are applied in order to study the plasma losses produced by the curvature of the magnetic lines. A Cs plasma was used with tantalum end plates. (D.L.C.)

27610 (MPI-PA-13/64) DENSITY PROFILES DETERMINED BY RESISTIVE DIFFUSION, "BOHM-DIFFUSION," LIKE-PARTICLE DIFFUSION AND RECOMBINATION. PART I. SPECIAL CASES. Guenter Grieger (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). Feb. 1964. 54p. Dep.(mn).

Density profiles are calculated for a plasma, taking into account resistive diffusion, Bohm diffusion, like-particle diffusion, and recombination. Special cases (resistive diffusion + recombination, etc.) are considered. Results of analog computations are given. (D.L.C.)

27611 (MPI-PA-14/64) THE RECOMBINATION COEFFICIENT IN A PLASMA CONFINED RADIALLY BY A STRONG MAGNETIC FIELD AND AXIALLY BY ELECTRON EMITTING ENDPLATES. Guenter Grieger (Max-Planck-Institut für Physik und Astrophysik, Munich (West Germany)). May 1964. 19p. Dep.(mn).

Plasma losses owing to ion recombination on the endplates of a Q-device plasma are analyzed. Endplate recombination processes are shown to dominate over volume recombination processes. It is assumed that the accommodation coefficient is unity for both neutrals and ions striking the endplate, and that neutrals and ions have an equal probability of leaving the endplate as ions. (T.F.H.)

27612 (MPI-PA-18/64) ON SECONDARY CURRENT IN TOROIDAL PLASMAS. D. L. Dimock (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). June 1964. 21p. Dep.(mn).

Secondary currents in a toroidal plasma may be canceled out by a scalloped magnetic field if the ratio of plasma diameter to the period of the field is very small. An attempt is made to minimize this restriction. A criterion is derived for the secondary currents to be divergence-free in a magnetic flux tube. This criterion is extended to neighboring flux tubes to first order for the two-dimensional system. Examples are calculated which satisfy the zeroth order criteria and minimize the first order. (D.L.C.)

27613 (N64-20193) VOLUME ION PRODUCTION IN A TENUOUS HELIUM PLASMA. Ronald J. Sovie and Barry M. Klein (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1964. 24p. (NASA-TN-D-2324) $0.75(CFSTI).

A theoretical calculation of the energy required for volume ion production was made for a partially ionized helium plasma in which a Maxwellian distribution of electron energies prevails. Inelastic electron-atom collisions that result in excitation of atomic energy levels are the only loss mechanisms considered. The energy is computed by considering the rates for the completing processes of excitation and ionization. The energy required for volume ion production decreases sharply from 78 to 43.5 ev/ion as the electron kinetic temperature increases from 6 to 60 ev and then decreases slowly to 40.8 ev/ion at an electron kinetic temperature of 100 ev. The ion production rate and the power consumed in ion production for a steady-state plasma are also presented as a function of electron kinetic temperature. (auth)

27614 (NASA-TN-D-2791) HYDROMAGNETIC STABILITY. S. P. Talwar (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1965. 15p. $1.00(CFSTI).

The problem of hydromagnetic instability is reviewed. The emphasis throughout is on the physical understanding rather than the mathematical rigor. The problem of gravitational instability is discussed in detail, and the effects of finite Larmor radius, finite Larmor frequency, and resistivity are reviewed. Only macroscopic instabilities are dealt with, and no attempt is made to cover all aspects of plasma stability. (auth)

27615 (NBS-TN-256) MICROWAVE REFLECTION TECHNIQUES FOR DENSE PLASMA DIAGNOSTICS. S. Takeda and T. Tsukishima (National Bureau of Standards, Washington, D. C.). Mar. 10, 1965. 31p. $0.25(GPO).

The microwave reflection method for measuring the electron density whose plasma frequency is higher than the probing frequency is described in detail. Various expressions and formulas which are useful for a variety of experimental conditions are given. A method to extend further the measurable density range is proposed. The fringing field effects are considered when a waveguide is used as a probe. References are given to the experimental work which substantiate the theoretical analyses. Also included are the analyses of reflection by a non-uniform boundary and also by an inhomogeneous plasma. (auth)

27616 (NP-14912) EXPERIMENTAL STUDY OF A HIGHLY IONIZED STEADY-STATE CESIUM PLASMA. Rijnhuizen Report 64-15. J. C. Terlouw (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Jan. 1964. 77p. Dep.(mn).

A number of experiments are described, which have been done in order to increase the understanding of the processes which determine the equilibrium in a highly ionized cesium discharge. The discharge is produced in a quartz tube, 55 cm long and with a diameter of 1.35 cm. The cathode is oxide-coated, the anode is air-cooled. At low pressures, the discharge characteristics show the behavior of an arc discharge. Measurements are taken at pressures between 1 and 15 micron Hg. Electron density and temperature are measured by using both probes and microwave diagnostics. The degree of ionization is found to vary between 0 and 40%. The electron velocity distribution turns out to be very nearly Maxwellian. The ionization occurs via excited atoms, their life time being prolonged by trapping of resonant radiation. Special attention is paid to the region of currents and pressures where the influence of atoms and ions on the plasma resistivity are about equal. By comparing the measurements in these regions with the theory, a value for the probability of collisions between electrons with an energy of 0.4 ev and cesium atoms is found: 745 cm^{-1} mm Hg^{-1}. At high currents, the plasma behaves as almost fully ionized. By using the measured electron temperature and density and Spitzer's formula, the conductivity is calculated and compared with direct measurements of this quantity. If a correction is made for the presence of atoms, which depends on the electron density distribution over the cross section, the agreement is within 10%. The diffusion of particles in the plasma is studied by measuring the density on the axis as a function of time in the afterglow. In the absence of an axial magnetic field the electron temperature is found to decrease very rapidly; this is because the fast electrons have such a long mean free path that they are lost to the walls in one transit time. In the highly ionized stage the plasma density is found to decline linearly in time, which is in accordance with a theory in which the diffusion coefficient is assumed to be inversely proportional to the ion density. The diffusion is also measured as a function of an axial magnetic field varying between 0 and 2500 Gauss, at a density where ions collide mainly with atoms. Quantitative agreement with the collisional diffusion theory is

ascertained if the loss of electrons to the end plates is taken into account. Some partly unexplained phenomena concerning plasma oscillations and cyclotron radiation are reported. (auth)

27617 (NSL-63-148-7) CROSSED-FIELD ACCELERATOR RESEARCH. Final Technical Report. Peter D. Lenn (Northrop Space Labs., Hawthorne, Calif.). Jan. 1964. Contract AF33(657)-11728. 42p.

The design, construction, testing, and performance analysis of a crossed-field plasma accelerator are given. (W.L.G.)

27618 (RADC-TDR-64-272) STABILITY OF AN IRRADIATED PLASMA SLAB UNDER CRITICAL POWER LOADING. E. T. Florance, R. V. Sillars, and J. I. F. King (Geophysics Corp. of America, Bedford, Mass.). Sept. 1964. Contract AF30(602)-3297. 50p. (AD-607435) $2.00(CFSTI).

The effects of an upper bound on the ionization frequency for a plasma slab irradiated with intense microwave power are investigated using a Chapman-function model. A quadrature algorithm is developed for the numerical computation of exact steady-state electron density profiles. The results for both stable and unstable profiles are analyzed in terms of a stability condition involving the deposition rate of microwave power. The dynamics of the electron distribution within the slab is treated approximately by constraining the density profiles to a sinusoidal form. A dynamical interpretation of stability then emerges from the approximate electron gain-loss equation. The stability problem is also formulated graphically by the introduction of a potential-like function. Steady-state characteristic curves for the plasma slab are calculated using sinusoidal density profiles; typical contours of constant net electron gain rate are similarly presented. (auth)

27619 (TID-21783) RADIOFREQUENCY PLASMAS AT THE HYBRID ION-ELECTRON RESONANCE. H. Schlueter and C. J. Ransom (Texas Univ., Austin. Plasma Physics Lab.). Jan. 1965. Contract AT(40-1)-3110. 46p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

For wave propagation perpendicular to the static magnetic field of plasmas a resonance is to be expected at the geometrical mean of the ion and electron cyclotron frequency is large compared to the electron cyclotron frequency. At this resonance, the so-called hybrid ion-electron resonance, the resistive impedance for an external power source has a minimum. Corresponding extrema in the loading of a steady state 10 kw oscillator are observed, virtually at the geometrical mean frequency. The observations are made in hydrogen, deuterium, and helium radio frequency plasmas for different oscillator frequencies from 13 to 30 Mc/sec and gas pressures from 5×10^{-3} to 6×10^{-2} mm Hg. The density condition for the occurrence of the hybrid resonance is fulfilled as spectroscopic, microwave, and probe density measurements show. (auth)

27620 (UCRL-11886) THE EFFECT OF WAVE-PARTICLE INTERACTIONS ON THE STABILITY OF A CURRENT-CARRYING PLASMA (thesis). Gary Arthur Pearson (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 4, 1965. Contract W-7405-eng-48. 152p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

The stability of a current-carrying electron-proton plasma is studied by calculating the velocity distributions of the particles with the Lenard-Balescu form of the Fokker-Planck equations rather than with the familiar Landau form. It is known that the Landau equations yield velocity distributions that become unstable to longitudinal ion waves when the temperature ratio θ_e/θ_i is large and the electric field E_0 that drives the current exceeds a critical magnitude E_{crit}. The Landau equations are then not adequate because they do not include the effect of the fluctuating electric fields associated with these ion waves upon the velocity distributions. As E_0 is increased to E_{crit} and beyond, the Lenard-Balescu equations show that the fluctuations associated with certain ion waves increase rapidly, drive the electron velocity distribution toward isotropy in the ion frame, and thus prevent the plasma from becoming unstable to any ion wave. For E_0 greater than E_{crit}, these fluctuations are just sufficient to maintain the stability. By distorting the velocity distributions of the particles, these wave-particle interactions also alter the transport properties of the plasma in much the same way as an increased collision frequency would do. The computer solutions obtained with $\theta_e/\theta_i = 70$ serve as examples. With $E_0 = E_{crit}$, the ion waves whose damping rate would vanish according to the Landau equations actually have a damping rate smaller by only a factor of 12 than with $E_0 = 0$. This damping rate decreases by another factor of 10 as E_0 is increased to 1.25 E_{crit}. The energy of the corresponding fluctuations increases by these same factors as E_0 is increased from zero, but the total energy in fluctuations associated with all ion waves only doubles as E_0 increases from zero to 1.25 E_{crit}. The electrical conductivity is lower than the value from the Landau equations by 4.6% at $E_0 = 0$, by 8.1% at $E_0 = E_{crit}$, and by 12.1% at $E_0 = 1.25$ E_{crit}; this correction becomes significant as E_0 is increased further. The plasmas to which the results of this problem would directly apply are restricted by the conditions for validity of the Lenard-Balescu equations. When these conditions are not met, other physical processes may also be of importance. For example, even in a high-temperature low-density plasma, as E_0 is increased the fluctuations associated with ion waves will be affected by collisions and by mode coupling. (auth)

27621 (UCRL-12207) DISPERSION RELATION FOR RELATIVISTIC STREAMS OF FINITE RADIUS. Ronald W. Landau (Lawrence Radiation Lab., Univ. of California, Livermore). Jan. 4, 1965. Contract W-7405-eng-48. 82p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The problem of instability and radiation emission from longitudinal plasma oscillations was examined. Assuming pure longitudinal motion, a dispersion relation for relativistic streams with finite radius was derived. The dispersion relation contains distinctly new terms and indicates that the two-stream instability can drive the plasma radiation. (W.L.G.)

27622 (CLM-Trans-6) THE PRODUCTION OF HOT THERMONUCLEAR PLASMA BY THE INJECTION OF FAST PARTICLES INTO A MAGNETIC TRAP. L. I. Artemenkov, G. F. Bogdanov, I. N. Golovin, et al. (Institut Atomnoi Energii Im. I. V. Kurchatova, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated from report IAE-676. 1964. 106p. Dep.; $2.80(BIS); 14s. (HMSO).

The possibility is considered of forming a dense hot plasma in a magnetic mirror trap by the injection of fast molecular ions and neutral atoms. The results are described of experiments carried out on OGRA to study the accumulation of plasma by the dissociation of molecular ions on the residual gas and by a lithium arc. During dissociation on the residual gas a hot plasma is obtained with a density of 10^8 ions/cm^3, and no losses from the trap are observed other than by charge exchange; i.e. no losses which might prevent the attainment of a higher plasma density by the injection into the trap of a large current of molecular ions. (auth)

27623 (FTD-TT-64-100) PLASMA DIAGNOSTICS. S. Lukvanov (Lukianov). Translated from Metanierеba Tekhn., No. 10, 4-7(1959). 11p. (AD-609143). $1.00 (CFSTI).

Some of the basic characteristics of a hydrogen plasma are described. The problem of measuring the homogeneity, pressure, and temperature of the plasma (diagnostics) is considered. Various ways of measuring plasma temperatures are discussed. (D.L.C.)

27624 (UCRL-Trans-1162(L)) ELECTRIC CONDUCTIVITY OF PLASMA WITH ELECTROSTATIC INSTABILITIES. E. A. Sukhomlin, V. A. Suprunenko, and N. I. Reva (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated by Sergey Shewchuck (Univ. of California, Lawrence Radiation Lab.). 1963. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.60(fs), $0.80(mf) JCL.

The electric conductivity of a dense plasma in a strong electric field is studied, under conditions in which the

processes connected with the formation of "escaping" electrons become dominant. These processes are found to have a collective nature. An anomalous rise in the electric resistivity with electric field is found, and is shown to be connected with the excitation of electrostatic instabilities, which cause a sharp drop in the current of "escaping" electrons. (T.F.H.)

27625 (UCRL-Trans-1170(L)) PLASMA WAVE GUIDES AND INTERACTIONS OF CHARGED PARTICLE BEAMS WITH BOUNDED PLASMAS. M. F. Gorbatenko (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Technicheskii Institut). Translated by Sergey Shewchuck (Univ. of California, Lawrence Radiation Lab., Livermore), from a thesis, Kharkov State University, Dec. 1963. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.10(fs), $0.80(mf) JCL.

A study was made of the propagation of electromagnetic waves in plasma wave guides. The plasma was assumed to be cold, and a double-component hydrodynamic approximation was used to describe the plasma. The interaction of a charged-particle beam with a bounded plasma is also treated kinetically with the double-component hydrodynamic approximation, assuming that the temperature of the plasma and beam is zero. (D.L.C.)

27626 ON THE DIFFUSION THEORY OF THE FARADAY DARK SPACE. G. Ecker and K. G. Emeleus (Universitat, Bochum, Ger. and Queens Univ., Belfast). Ann. Physik (7), 15: 53-9(1965).

The charged particle density distribution in the Faraday dark space is calculated on the basis of a production-free diffusion model. The solution of this problem determines the number density at the edge of the glow and produces a criterion for the extension of the Faraday dark space as a function of the current and pressure. (auth)

27627 CATHODIC INSTABILITY OF THE GLOW DISCHARGE. G. Ecker, W. Kroell, and O. Zoeller (Universitat, Bochum, Ger.). Ann. Physik (7), 15: 60-8(1965). (In German)

The stability of the cathodic parts of a glow discharge with respect to local current density disturbances is investigated. The cathodic region is described by the particle and momentum balances of the charge carriers and the boundary conditions at the cathode surface and the negative glow. The latter are formulated with the help of the coefficients γ and δ. From a first-order perturbation theory of the stationary mode, a dispersion relation is derived. The evaluation of this equation using Nyquist's theorem provides a criterion for the onset of the $\gamma-\delta$ instability. (auth)

27628 LIMITS AND ENLARGEMENT OF THE LANGMUIR PROBE THEORY. G. Ecker and J. McClure (Universitat, Bochum, Ger.). Ann. Physik (7), 15: 69-86(1965). (In German)

Deviations from Langmuir's probe theory occur if the extension of the space-charge region, the density — or the temperature disturbance is larger than the mean free path of the ions. The range of experimental parameters where the deviations become important is discussed. Different effects are to be expected depending on the experimental set-up. An analysis is presented for the characteristic case of a density-limited probe. The results allow to unfold experimental data. They also shed light on the meaning of "Bohm's criterion." (auth)

27629 CORRELATED INTERFEROMETRIC MEASUREMENTS OF PLASMA ELECTRON DENSITIES AT OPTICAL AND MICROWAVE FREQUENCIES. J. B. Gerardo and J. T. Verdeyen (Univ. of Illinois, Urbana). Appl. Phys. Letters, 6: 185-7(May 1, 1965).

Measurements were made of the small changes in the refractivity of an argon plasma at optical wavelengths using a three-mirror laser interferometer, and were correlated with measurements obtained with a 70 Gc microwave interferometer. The laser data represent an average density change integrated along the length of the plasma tube whereas the microwave data represent an average across the cross section. The results indicate good agreement between the plasma electron density measured at optical and microwave frequencies. A large fractional decrease in neutral atom concentration was observed along the axis of the discharge tube; and it is suggested that the migration of atoms away from the tube axis is due to localized axial heating of the gas by the electric discharge. (L.B.S.)

27630 OBSERVATIONS OF PULSED PLASMA WAVES IN AFTERGLOWS. H. J. Schmitt (Sperry Rand Research Center, Sudbury, Mass.). Appl. Phys. Letters, 6: 187-9 (May 1, 1965).

Delayed echoes were observed in the afterglow of a neon plasma column ignited repetitively in a 50-cm-long cylindrical discharge tube. Electromagnetic fields are coupled to the plasma column by two separate strip lines. One strip line was used to monitor the reflected power of a continuous-wave signal which exhibits Tonks–Dattner plasma resonances during the decay of the plasma column; the reflection of the r-f pulse from the plasma column was measured on a sampling scope using the second strip line in conjunction with a broad-band directional coupler. The time delay between the peak of the first echo and the center of the applied signal measured at four different frequencies, is shown as a function of the time in the afterglow at which the measurement is made. Fair correlation was obtained between the measured time delay and that calculated by the Bohm-Gross dispersion relation. (L.B.S.)

27631 QUASI-ELECTROSTATIC INSTABILITIES CREATED BY THE CURRENTS IN A HOT AND CYLINDRICAL INHOMOGENEOUS PLASMA. Paul-Henri Rebut (CEN, Saclay, France). Compt. Rend., 260: 1882-5 (Feb. 15, 1965). (In French)

The study of the dispersion relation for quasi-electrostatic waves makes it possible to calculate the marginal modes (real frequency) which separate the stable domain from the instable domain. The fundamental mode and the stabilizing influence of various parameters are studied. (tr-auth)

27632 PROBLEM OF INVESTIGATION OF EIGENVALUES AND EIGENFUNCTIONS OF THE FOKKER-PLANCK OPERATOR. Gabrielle Berthomieu (Institut d'Astrophysique, Paris). Compt. Rend., 260: 1886-8 (Feb. 15, 1965). (In French)

In order to use the Fokker-Planck equation for the study of a wave of low amplitude in an ionized medium, the linearized collision operator of this equation is considered. The problem of the investigation of the eigenvalues and eigenfunctions under a form capable of numerical application is posed. (tr-auth)

27633 GENERAL CHARACTERISTICS OF THE INSTABILITIES OF A HOT INHOMOGENEOUS PLASMA IN CYLINDRICAL GEOMETRY AND CONDUCTIVITY TENSOR. Paul-Henri Rebut (Euratom-C.E.A., Fontenay-aux-Roses, France). Compt. Rend., 260: 2150-3(Feb. 22, 1965). (In French)

By a perturbation method in the space of the first integrals of free movement, the perturbed distribution function of the particles can be obtained from the Vlasov equation. This permits the calculation of the conductivity tensor, and in a closed system the conservation of energy imposes some properties of the marginal modes. (tr-auth)

27634 NUMERICAL STUDY RELATIVE TO THE FOKKER-PLANCK OPERATOR. Gabrielle Berthomieu (Institut d'Astrophysique, Paris). Compt. Rend., 260: 2450-2(Mar. 1, 1965). (In French)

A numerical application of the problem of eigenvalues and eigenfunctions of the linearized Fokker-Planck operator was made to the case of an isotropic distribution function. (tr-auth)

27635 THEORETICAL STUDY, IN THE VICINITY OF THE RESONANCE, OF FORCED OSCILLATIONS OF A COLUMN OF HEAVY, VISCOUS, AND ELECTROCONDUCTOR LIQUID IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Etienne Crausse, Francois Dorlhac, and Yves Poirier (Centre d'Enseignement Superieur

Scientifique, Avignon, France). Compt. Rend., 260: 2711-13(Mar. 8, 1965). (In French)

A theoretical study is made, in the vicinity of the resonance, of laminar and sinusoidal forced oscillations of a heavy, viscous, and electrically conducting liquid moving between undefined vertical parallel planes in the presence of a transverse magnetic field. Curves tracing the variations of the amplitude of oscillations of the liquid column are given for various values of the fundamental parameters. (tr-auth)

27636 CALCULATION OF THE THERMODYNAMIC PROPERTIES OF PARTIALLY IONIZED HYDROGEN, TAKING ACCOUNT OF ELECTROSTATIC INTERACTIONS. Pierre Fauchais and Numa Manson (Faculte des Sciences, Poitiers, France). Compt. Rend., 260: 2729-32 (Mar. 8, 1965). (In French)

The calculations made by adopting the expression for the Ecker and Kroll interaction potential show that the thermodynamic properties of hydrogen plasma at $T \leq 25{,}000°K$ and $p \leq 10$ atm can be evaluated with a relative uncertainty less than 4% by comparing this plasma to a perfect gas the sum of electron state of which is limited by the method proposed by Gurvich and Kvlividze. (tr-auth)

27637 HIGH-FREQUENCY OSCILLATIONS AND ACCELERATION OF ELECTRONS IN A DISCHARGE OF THE PIG TYPE WITH COLD CATHODES. Samuel Bliman, Andre Bouchoule, and Albert Septier (Faculte des Sciences, Orsay, France). Compt. Rend., 260: 2751-4(Mar. 8, 1965). (In French)

Experimental apparatus for the measurement of h-f oscillations and electron acceleration in a PIG discharge is described. The results showed that in certain regions the existence of an intense emission of h-f signals with a stable and quasimonochromatic amplitude could be observed. The oscillations exist only on three preferred frequencies, never in a simple ratio. The existence of a system of relatively simple stationary waves was shown. The wave emitted seemed to have a complex structure. An analysis of the electron velocities showed the simultaneous appearance of the h-f emission and a considerable quantity of accelerated electrons. This simultaneous appearance suggested the existence in the PIG discharge of interaction phenomena between two beams of fast electrons emitted from the cathodes and the stationary plasma. (J.S.R.)

27638 CONTRIBUTION TO PROBLEM OF INTERACTION BETWEEN H-F ELECTROMAGNETIC FIELD AND PLASMA. L. Bednar (Inst. of Plasma Physics, Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 15: 325-32(1965).

Magnetoactive plasma is regarded as an anisotropic compressible dielectric. A thermodynamical method is used to solve the interaction of plasma with an h-f field which fully penetrates into it. Assuming isothermicity, the equilibrium state is reached in the minima of free energy. The case of cylindrical configuration is solved in detail; the equilibrium plasma frequencies are determined. The influence of electron collision frequency is analyzed. (auth)

27639 QUANTUM KINETIC EQUATION FOR CHARGED PARTICLE SYSTEM CONSIDERING PARTICLE INTERACTIONS WITH WAVES. Yu. L. Klimontovich and Yu. A. Kukharenko (Moscow State Univ.). Fiz. Metal. i Metalloved., 19: 161-8(Feb. 1965). (In Russian)

A quantum kinetic equation is found, taking into consideration both collisions of particles and their interactions with the collective oscillations of the system; the exchange correlation of particles and the change of the wave spectrum with time are also studied. The latter leads to the appearance of new terms in the equation for the wave distribution function. (tr-auth)

27640 PLASMA DIAGNOSIS BY MEANS OF OPTICAL SCATTERING. S. E. Schwarz (California Inst. of Tech., Pasadena). J. Appl. Phys., 36: 1836-41(June 1965).

When a pulse of intense light from a laser passes through a plasma, a very small fraction of the light is scattered out of the beam by free electrons. Measurements of the intensity and spectral distribution of the scattered light can be related to the electron density and velocity distribution in the plasma. A general discussion of the use of optical scattering as a plasma diagnostic technique is presented. Applicability to various experimental situations is discussed, and considerations of interest in the design of diagnostic apparatus are presented. An apparatus was constructed for the measurement of electron density in cold plasma. The apparatus is described in some detail. Typical results are given for densities as low as 10^{13} electrons/cm^3. (auth)

27641 REDUCTION OF ELECTROMAGNETIC BACKSCATTER FROM A PLASMA-CLAD CONDUCTING BODY. E. L. Murphy (Massachusetts Inst. of Tech., Lexington). J. Appl. Phys., 36: 1918-27(June 1965).

The investigation of dipole resonance effects in electromagnetic scattering from cylindrical plasma columns is currently directed toward understanding the observed multiplicity of resonances and the effect of magnetic fields, finite temperature, glass envelopes, etc., on these resonances. When a conducting core is embedded in the column, the analysis shows that not only are the shapes and locations of the resonances modified, but in addition, the possibility then exists for a decrease in the backscatter cross section considerably below the value for the conducting core itself. Although such plasma-conducting core configurations may not be realizable in the laboratory, large decreases or dips in the electromagnetic backscatter from hypersonic projectiles have been observed, and there is the possibility that an ionized cloud surrounding the projectile is responsible for the dip, perhaps through the mechanism described. An analysis of this resonance-dip phenomenon is described in some detail for the problem of a cylindrical or spherical conducting core surrounded by a uniform concentric plasma layer. (auth)

27642 DIFFUSION IN A MICROWAVE PLASMA IN THE PRESENCE OF TURBULENT FLOW. W. B. Cottingham (Bell Telephone Labs., Inc., Whippany N. J.) and S. J. Buchsbaum. J. Appl. Phys., 36: 2075-8(June 1965).

Microwave breakdown and diffusion in a weakly ionized microwave plasma was studied in the presence of turbulent flow of the neutral gas. Breakdown was produced by pulsed microwaves in helium, hydrogen, nitrogen, and argon in a tube placed along the E field of an S-band waveguide. The microwave power at breakdown (or at extinction) is a measure of the diffusion rate of the charged particles to the walls of the tube. This power was measured as a function of flow rate of the neutral gas. The minimum microwave breakdown power exhibits a sharp upward break when turbulent flow sets in. (auth)

27643 CALORIMETRIC MEASUREMENTS OF A PULSED-PLASMA ACCELERATOR. William J. Guman (Republic Aviation Corp., Farmingdale, N. Y.). J. Appl. Phys., 36: 2092-3(June 1965).

The use of a calorimeter to determine the total energy of the plasma ejected from a pulsed-plasma accelerator is described. The calorimetric measurements are carried out under steady-state conditions rather than under transient conditions. Plasma-exhaust power becomes dissipated in the calorimeter and raises the calorimeter temperature to equilibrium. This equilibrium temperature is established when the power radiated by the calorimeter becomes equal to the power transferred to the walls of the calorimeter. A calibration curve of the calorimeter presents calorimeter equilibrium temperature as a function of the power required to raise the calorimeter temperature to equilibrium. (C.E.S.)

27644 SPACE-CHARGE WAVES CARRIED BY A PLASMA TRAPPED IN A POTENTIAL WELL. F. D. Kahn (Univ. of Manchester, Eng.). J. Fluid Mech., 21: 705-22 (Apr. 1965).

A mono-energetic electron plasma is trapped in a one-dimensional parabolic potential well. In the undisturbed state a suitable background charge provides space-charge

neutrality. It is shown that stationary disturbances of infinitesimal amplitude can exist in the plasma for certain critical values of the parameter $\Lambda = 4\pi\bar{n}e^2/m\omega^2$, where $\bar{n}$ is the mean electron density and $\omega/2\pi$ is the frequency of oscillation of the electrons in the well. The first few critical values are $\Lambda = 0, 4.12, 8.2$. The boundary conditions at the end of the plasma are non-linear. As a result stationary disturbances of finite amplitude in a given mode (the rth for instance) require that Λ shall exceed Λ_r. Further, it can be shown that disturbances of small amplitude in the rth mode are unstable when Λ exceeds Λ_r. This applies even for $\Lambda_r = 0$; in this case there exist nearby an unstable even and an unstable odd mode. It seems likely that these results can be extended to all cases in which the potential well is symmetrical. (auth)

27645 DIELECTRIC CONSTANT AND BROWNIAN MOTION. R. Balescu (Universite Libre, Brussels) and Y. Soulet. J. Phys. (Paris), 26: 49-58(Feb. 1965). (In French)

The theory of the dielectric constant is developed in a general way from the Liouville equation. A completely general expression is derived in which no assumption is made about the nature of the medium or even about its stationarity. For the long-time response, a simpler expression results. It is shown that the coefficients of the Fokker-Planck equation describing the motion of a particle weakly coupled to the medium can be expressed in terms of this quantity. A generalization of the dielectric constant is then introduced, in which it is no longer assumed that the coupling between test particle and medium is small. This expression becomes tractable only if it is assumed that the test particle is heavy. It is then shown that the coefficients of the classical Fokker-Planck equation (motion of a heavy particle in a medium of light particles in equilibrium) are expressed entirely in terms of the generalized dielectric constant. (auth)

27646 ION-DENSITY PROFILE OF THE FLOW IN AN ELECTRIC SHOCK TUBE. Ri'ichi Matsuzaki (National Aerospace Lab., Tokyo). Japan. J. Appl. Phys., 4: 218-24(Mar. 1965).

The ion-density profile of the flow in an electric shock tube was measured using a probe method, and the results are discussed under the assumption that the ion flow is one-dimensional, isentropic and electrohydrodynamic. The measured profile is considered to consist of two parts: a uniform region and a trailing region. In the trailing region, there exists a slight ion excess of the order of the square root of the ion density in the uniform region. The effect of recombination on the peak value of the probe signal is briefly discussed. (auth)

27647 THE CRITICAL ELECTRIC FIELD INTENSITY FOR ADJUSTING A STEADY ELECTRON TEMPERATURE IN HIGHLY IONIZED PLASMA. H.-B. Valentini (Inst. of Magnetohydrodynamics, Jena, Ger.). Monatsber. Deut. Akad. Wiss. Berlin, 6: 833-8(1964). (In German)

The critical electric field intensity is evaluated beyond which no steady electron temperature in a highly ionized plasma can be established. This critical field intensity occurs at an electron temperature which is equal to 1.5 times the ion temperature. The steady-state drift velocity and electron temperature are derived on the basis of Coulomb interaction during the energy transfer from the electron gas to the ion gas. There is assumed to be no energy loss in the electron gas by retardation radiation, heat conductivity, or escape of fast particles. The derivation is valid as long as instabilities are neglected which may cause an amplification of the energy transfer. (CFSTI)

27648 ABSORPTION AND EMISSION PROFILES OF LINE RADIATION IN NONEQUILIBRIUM. M. Dobrowolny and F. Engelmann (EURATOM-CNEN, Frascati, Italy). Nuovo Cimento (10), 37: 965-76(June 1, 1965).

It is investigated under which conditions the absorption and emission profiles of a spectral line radiated from a spherical scattering atmosphere are approximately equal even if there is no equilibrium excitation. The velocity distribution of the particles of the atmosphere is assumed Maxwellian, and only Doppler broadening of the line is taken into account. In particular, the effect of different angular dependences of the radiation field is considered. The result is that the absorption and emission profiles are in any case to a good approximation equal if the optical thickness of the atmosphere is less than about 100. (auth)

27649 STABILITY OF A SLIGHTLY INHOMOGENEOUS SEMI-INFINITE PLASMA. Som Krishan (Univ. of Delhi). Nuovo Cimento (10), 37: 1170-9(June 1, 1965).

A collisionless semi-infinite plasma in equilibrium with a slightly nonuniform magnetic field is studied to determine its stability against growing low-frequency longitudinal electrostatic oscillations. The procedure is to expand the velocity distribution function about its equilibrium value and to use the Maxwell's equations to obtain eigenfrequency of oscillations. For stability apart from the condition that $(kR_i)^2 > 16g(\alpha/\epsilon')$ (obtained by Rosenbluth and Krall, the plasma should also satisfy $1 > \epsilon'/k > \frac{3}{4}\sqrt{\pi}kR_i$ where k is the wave vector, R_i the ion Larmor radius, α the inverse of the square of the thermal velocity, g the gravity, and $(2\alpha g - \epsilon')$ is the normalized density gradient. (auth)

27650 THE INTERACTION OF MICROWAVES WITH THE CATHODE FALL AND NEGATIVE GLOW IN A GLOW DISCHARGE. P. J. W. Severin (Rijksuniversiteit, Utrecht). Philips Res. Rept., Suppl. No. 2, 1-89(1965).

Starting from the linear electric field in the cathode fall of a glow discharge, the motion of electrons and ions is described. The electron distribution function is treated by means of a simple model, and the result is tested with the aid of the Boltzmann equation. The velocity of the ions in a uniform field of arbitrary strength is discussed, and the equations found are modified to make them apply to the case of a strong linear field. The perturbations in the motion of ions and electrons, caused by an extra a-c voltage in the r-f region, are derived; theory and experiment show good agreement. The non-linear response of the electron motion on an extra a-c field of microwave frequency is calculated; the experiments showing this effect are discussed at some length. Finally, the influence of microwave radiation on the optical spectrum emitted by the flow is investigated; for He, He_2, Ne, and Ar quenching has been found to a degree depending on the spectral line considered. The suggested explanation of this effect is based on the form of the cross section as a function of the kinetic energy of the incident electron for excitation from ground or metastable levels. (auth)

27651 RESISTIVE OVERSTABILITIES AND ANOMALOUS "DIFFUSION." Francis F. Chen (Princeton Univ., N. J.). Phys. Fluids, 8: 912-19(May 1965). (MATT-306)

A physical picture is given of microinstabilities which can occur in plasmas of finite resistivity with or without an effective gravitational field, and of finite Larmor radius stabilization. The drift waves become overstable because of a phase shift between the density and potential fluctuations. Transport of plasma across a magnetic field also arises from this phase shift; this transport does not necessarily resemble a diffusion process. This mechanism may account for the anomalous diffusion commonly observed in fully ionized plasmas. Particular attention is paid to the real part of the frequency and to the phase correlations, which can easily be measured to test this hypothesis. In regard to stellarator pumpout, it is found that increasing the conductivity will not reduce the part of the loss rate which is due to the universal resistive overstability. (auth)

27652 NONLINEAR STABILITY OF THE EXTRAORDINARY WAVE IN A PLASMA. Robert D. Engel (Univ. of California, Los Angeles). Phys. Fluids, 8: 939-50(May 1965).

The linear theory predicts that certain anisotropic velocity distributions will produce unstable extraordinary waves. The development of these unstable waves in the nonlinear regime is investigated and their final amplitudes are estimated. The analysis is restricted to infinite homogeneous plasmas where the background distribution and the wave

energy density may be considered as slowly varying functions of time. A set of nonlinear integro-differential equations, which describe the evolution of the system, are derived and discussed. For the physically interesting case where the wave frequency is much less than the cyclotron frequency, the basic behavior of the system and the characteristics of the equilibrium solutions may be estimated without computing the transient behavior of the system. For this case, it is shown that the main diffusion of the background distribution occurs along the v = const lines, in which v is the magnitude of the velocity. Since these lines are also constant energy lines, very little energy is transferred to the waves during the diffusion process. A Maxwellian plasma which has been disturbed by injecting a stream of electrons into it is considered as an example. (auth)

27653 GENERAL CRITERION FOR MIRROR INSTABILITY OF A PLASMA. D. J. Rose (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 8: 951-5(May 1965).

A plasma column in an axial magnetic induction B exhibits the well-recognized mirror instability if the pressure $p_\perp$ perpendicular to B becomes too high, as follows. A small small azimuthally symmetric bulge in the field may trap additional plasma via the usual mirror effect. The increased diamagnetism further weakens the field in the bulge, thus trapping more plasma, and so forth. The criterion for stability against this mode for an azimuthally symmetric velocity distribution function $f(v,\theta)$ is $\int_0^\infty dv \int_0^{\pi/2} d\theta\ \pi m v^4 \sin^3\theta \tan\theta(\partial f/\partial\theta) < (B_e^2/2\mu_0)\{1-\beta+[\kappa\rho K_0(\kappa\rho)/2K_1(\kappa\rho)]\}$. Here, v is speed, m is mass, θ is colatitude angle, and B_e is the uniform induction outside the plasma; $\beta = 2\mu_0 p_\perp/B_e^2$ is (plasma perpendicular pressure/total pressure), κ is axial wavenumber of the unstable mode, and ρ is plasma column radius; K_0 and K_1 are modified Bessel functions of the second kind. The integral is a measure of changing $p_\perp$ if an incipient bulge forms in the plasma column; the $\kappa\rho$ term represents stabilizing effect of a finite wavelength perturbation. This criterion is more general than the two-temperature criteria obtained hitherto. (auth)

27654 ELECTROMAGNETIC WAKE A CHARGED-PARTICLE PULSE IN A PLASMA. S. V. Yadavalli (Stanford Research Inst., Menlo Park, Calif.). Phys. Fluids, 8: 956-67(May 1965).

Employing the hydrodynamic approach, the electromagnetic wake of a charged particle pulse passing through a plasma is investigated. The perturbation in the magnetic field amplitude $B_\theta^{(1)}$ which is of interest in the study of hose instability of the beam is evaluated. The effect of charge density profile and different velocity regimes of the beam pulse on the behavior of $B_\theta^{(1)}$ is considered. Numerical results relevant to a typical example are presented. (auth)

27655 EFFECT OF FINITE ION AND ELECTRON TEMPERATURES ON THE ION-CYCLOTRON RESONANCE INSTABILITY. G. K. Soper and E. G. Harris (Univ. of Tennessee, Knoxville and Oak Ridge National Lab., Tenn.). Phys. Fluids, 8: 984-90(May 1965). (ORNL-P-1185)

The ion-cyclotron resonance instability theory as first developed by Harris is extended to include finite ion and electron temperature effects. With anisotropic ion and electron temperatures the dispersion relation due to Harris is subjected to numerical analysis and stability zone boundaries in the two-dimensional parameter space representing essentially the magnetic field strength and the electron density is obtained. The effect of a uniform rotation of the ions with respect to the electrons is also included. Comparison of the results of this analysis with some experimental observations is possible. (auth)

27656 SPECTRUM OF NEUTRAL AND ION DENSITY FLUCTUATIONS IN AN EQUILIBRIUM TURBULENT PLASMA. Harold Guthart (Stanford Research Inst., Menlo Park, Calif.). Phys. Fluids, 8: 999-1000(May 1965).

The electromagnetic interaction with a turbulent plasma is governed by the statistical behavior of the electron fluctuations. In a weakly ionized plasma that is in chemical equilibrium the electronic and ionic fluctuations are not necessarily the same as the neutral (fluid) fluctuations. The relation between the neutral and ion density fluctuations in an equilibrium turbulent plasma is determined. (C.E.S.)

27657 LANGMUIR-PROBE-MEASUREMENT METHOD FOR TURBULENT PLASMAS. A. Demetriades and E. Doughman (Philco Corp., Newport Beach, Calif.). Phys. Fluids, 8: 1001-2(May 1965).

A direct and simple method for measuring quantitatively the electron density fluctuation in a turbulent plasma is discussed. The technique is based on the use of the Langmuir probe in the context originally discussed by Langmuir and Mott-Smith. (C.E.S.)

27658 PLASMA DIAGNOSTICS WITH MODERATELY LARGE LANGMUIR PROBES. S. H. Lam (Princeton Univ., N. J.). Phys. Fluids, 8: 1002-4(May 1965).

A rigorous analysis (S. H. Lam, Phys. Fluids, 8: 73(1965)) of the collisionless Langmuir probe problem using the model of mono-energetic ions of Bernstein and Rabinowitz is considered. The results of this analysis are formally valid in the asymptotic limit of $\xi_e \to \infty$ where ξ_e is the ratio of the probe radius to the Debye-length of the plasma. However, in the laboratory, the values of ξ_e encountered are usually only moderately large. In order to appraise and improve the accuracy of the asymptotic theory for moderately large probes, the leading corrections for finite ξ_e are presented. (C.E.S.)

27659 DEMONSTRATION OF THE MINIMUM B STABILITY THEOREM FOR THE UNIVERSAL INSTABILITY. M. N. Rosenbluth and N. A. Krall (General Atomic Div., General Dynamics Corp., San Diego). Phys. Fluids, 8: 1004-5(May 1965).

An attempt is made to indicate the relation between the universal instability and the general minimum B stability theorems and to indicate Taylor's theorem directly for the universal instability mode. A low-β, collisionless, plasma magnetic field equilibrium where the density of the plasma decreases with coordinate x and the magnetic field $B_z(x)$ is everywhere in the z direction is considered. (C.E.S.)

27660 TRANSVERSE FIELDS, HALL CURRENTS, AND ELECTRON DRIFT VELOCITIES IN A Θ-PINCH. Alan C. Kolb (Naval Research Lab., Washington, D.C.), Peter C. Thonemann, and Edward Hintz. Phys. Fluids, 8: 1005-6(May 1965).

A Pharos Θ-pinch experiment was used to investigate a previously predicted rotating magnetic dipole in plasma. The observation of the magnetic field due to a rotating dipole would establish direct evidence for Hall currents and a torque. In addition it would provide a diagnostic technique for determining electron drift velocities, the resistive decay time of plasma currents, and electron densities in the current sheath if the skin depth were known. The presence of such a rotating dipole was established. (C.E.S.)

27661 ELECTRON CYCLOTRON HARMONIC RADIATION FROM A PLASMA. A. K. Kuckes and J. M. Dawson (Princeton Univ., N. J.). Phys. Fluids, 8: 1007-8(May 1965).

Microwave radiation emitted from plasma immersed in magnetic fields has been observed to be surprisingly intense at harmonics of the electron cyclotron frequency. It is proposed that this radiation is due to energetic electrons gyrating in a region of plasma hybrid resonance. Calculations are performed for a plasma slab of two distinct electron energy distributions. (C.E.S.)

27662 ONE-DIMENSIONAL CONDUCTIVITY KERNEL. D. R. Dobrott (New York Univ., New York). Phys. Fluids, 8: 1008-11(May 1965).

The dynamical response of a quiescent, neutral plasma to a perturbation has been characterized as a generalized Ohm's law. This generalization for a spatially uniform plasma, where the electric field is nonvortical, is expressed in terms of a one-dimensional conductivity kernel. The kernel is derived from the linearized, one-dimensional

Vlasov equation and is expressed in terms of a zero-order, time-independent distribution function $f_0(v)$, where v is the velocity. Numerical calculations of this kernel are made for various distribution functions $f_0(v)$. (C.E.S.)

27663 THE PHYSICS OF VERY HOT PLASMA. L. A. Artsymovich. Priroda, No. 4, 17-24(Apr. 1965). (In Russian)

A short review is given of the characteristics and properties of cold and hot plasma. Particle interactions in plasma, plasma interactions with a magnetic field, magnetic traps, plasma pinch, toroidal discharge chambers, plasma instability, and plasma instability as a source of fast particles are discussed. (R.V.J.)

27664 THE ELECTROMAGNETIC CHARACTERISTICS OF ARC COLUMNS. F. Dennery (Laboratoires Centraux de l'Air Liquide, Paris). Rev. Hautes Temp. Refractaires, 1: 277-94(Oct.-Dec. 1964). (In French)

The electromagnetic characteristics of arc columns (plasma columns through which there is a continuous current and which circulate between a flat plate or a hollow cylinder, which serves as the anode, and a cathode of very small dimensions) are studied. It is shown that the plasma torch based on the principal of a hollow cylindrical anode is complementary to the traditional arc used in welding electrometallurgy, which makes use of a flat anode. The results of the study of these schematic models are not complete because only the almost unpolarizable conducting properties of the plasma were used. The gaseous and dissociatable properties of a plasma are noted; the influence of the mechanical properties of fluids, thermokinetics, and the physico-chemical structure, all of which influence the thermodynamics of arcs, are briefly considered. (auth)

27665 COMPOSITION AND THERMODYNAMICS OF A MIXTURE OF ARGON AND HYDROGEN. Alassane Abdoul Sy and Francois Cabannes (C.N.R.S., Bellevue, France). Rev. Hautes Temp. Refractaires, 1: 295-307 (Oct.-Dec. 1964). (In French)

The influence of electrostatic interactions between charged particles on the composition and thermodynamics of a plasma are studied. The plasma considered is a mixture of argon and hydrogen, the proportion of hydrogen increasing from 1 to 20%, in volume percentage. The methods of calculation developed can be used for any gas mixture. (auth)

27666 COMPARISON OF EMISSION SPECTRA OBTAINED BY THE CONTINUOUS ARC IN A CONTROLLED ATMOSPHERE AND BY THE PLASMA TORCH. Jacqueline Vilnat (Centre National d'Etudes et Recherches Ceramiques, Paris). Rev. Hautes Temp. Refractaires, 1: 309-20(Oct.-Dec. 1964). (In French)

A controlled atmosphere device—the double injector—was developed. It permitted, in a continuous arc, the suppression of the cyanogen bands and revealed certain lines having a high excitation potential, particularly of the halogens, sulphur and selenium, using a helium atmosphere. Tests with a plasma torch confirmed the observations made with the continuous arc for the gases used—argon and helium. It is also shown that a plasma torch can be used as a source for atomic or molecular emission. (auth)

27667 EFFECT OF THE GEOMETRY OF THE ELECTRODES OF A COAXIAL GUN ON THE PARAMETERS OF PLASMA CLUSTERS. A. O. Kalmykova, V. G. Marinin, F. V. Sivagin, and A. D. Timofeev. Ukr. Fiz. Zh., 9: 1023-5(1964). (In Russian)

The performance of a plasma accelerator, consisting of 2 coaxial, stainless steel cylinders provided with 8 discharge condensers having a total capacity of 4 μfarad, a potential of 19 kv, and a discharge period of 3.2 μsec, was examined. The plasma clusters produced by this source were studied by a mass spectrometer with a 20-kw resolution. The ion components of the plasma clusters discharged under special conditions, such as at varying intrinsic electrode length or varying time delay between discharges were plotted. The results indicated the appearance of clusters with velocities of 6 to 8×10^7 cm/sec and 1×10^7 cm/sec after delay periods ranging from 220 to 300 μsec. When the delay period was extended to 300 to 600 μsec, the faster cluster disappeared. It was also found that, except for the condensed volume, neither the electrode materials, nor the discharge parameters affected the density or the velocity of the clusters; on the other hand, geometrical changes, such as varying electrode length, did influence the rate and number of the fast ions and the total energy of the cluster. The mechanism of the acceleration of the clusters in a coaxial source differs from previously described mechanisms. (TTT)

27668 MEASUREMENT OF AVERAGE ENERGY LOSSES OF ELECTRONS IN SCATTERING OF AN ELECTRON BEAM IN A PLASMA. L. L. Pasechnik. Ukr. Fiz. Zh., 9: 1027-30(1964). (In Russian)

A method was developed for measuring the mean energy losses occurring in strongly anomalous electron scattering in a plasma. A low-inertia Ni band bolometer was used for measuring the plasma parameters in an arc discharge with a cold cathode at about 1×10^{-3} mm Hg. The measurements were carried out at an electron energy range of $E^0 = 50$ to 150 ev and a plasma density of $N_e = 10^9$ to 10^{11} cm^{-3}. It was found that the value of $\Delta E/E$ is independent of N_e, reaching 20% at $E^0 = 150$ ev. The mean electron energy loss value obtained, ranging from 10 to 20% agrees well with the concept of coherent electron beam interaction with the plasma. (TTT)

27669 TRANSPORT PROPERTIES OF NON-EQUILIBRIUM IONIZED ARGON GAS. C. W. Tan (Cooper Union, New York), S. L. Soo, and M. N. Bahadori. Z. Angew. Math. Phys., 16: 255-78(Mar. 25, 1965).

The transport properties of a non-equilibrium plasma in which ionization is produced by an applied electric field were investigated experimentally and theoretically. The diffusivity, viscosity, electric conductivity, and thermal conductivity of a multicomponent plasma were calculated. The dependence of the electron and gas temperatures on the pressure and applied field was considered, together with the various collision mechanisms. Measurements were made in both the low-temperature glow and high-temperature arc discharge regions using argon. 51 references. (D.C.W.)

27670 FUNCTION THEORY DETERMINATION OF THE EXTERIOR FIELD FOR A TWO-DIMENSIONAL MAGNETOHYDROSTATIC CONFIGURATION. Rudolf Gorenflo (Institut fur Plasmaphysik GmbH, Munich). Z. Angew. Math. Phys., 16: 279-90(Mar. 25, 1965). (In German)

Two-dimensional analogs of the torus-like Meyer-Schmidt plasma configurations without interior field are treated by function-theoretical methods. If the boundary of the doubly connected plasma domain consists of two closed analytic curves, the structure of the exterior magnetic field and its singularities (which determine the currents) can be found by a combination of analytic continuation and conformal mapping. An example is discussed in detail. The problem is essentially equivalent to a problem in hydrodynamics: to find the structure of an incompressible irrotational flow in two dimensions which has a given closed analytic curve as a free streamline. (auth)

27671 THE DISTRIBUTION OF ELECTRIC MICROFIELDS AND MICROPOTENTIALS IN PLASMA. Klaus Weise (Technische Hochschule, Hanover). Z. Physik, 183: 36-50(1965). (In German)

The microfield and micropotential distributions at a neutral space point in a completely ionized hydrogen plasma were calculated by an expanded method of Baranger and Mozer. The interaction of the plasma carrier was treated with the help of the Green normalizable, semi-classical, canonical energy distribution of the plasma. As a microfield distribution, a Holtsmark distribution appears with a correction that displaces the maximum of the distribution to smaller field strengths; and, as a micropotential distribution, a Gauss curve appears with a deviation that increases the probability for small and large potentials and reduces the probability for average potentials. The results are valid from 10^4 up to 10^{9}°K and up to a carrier density of about 10^{24} cm^{-3}. (tr-auth)

27672 THE PLASMA BOUNDARY LAYERS AT SMALL FREE PATH LENGTHS. Guenther Schulz (Universitat des Saarlandes, Saarbrucken, Ger.). Z. Physik, 183: 51-64 (1965). (In German)

With the present investigation on the charge and potential behavior in the vicinity of a wall in contact with a quasi-neutral plasma, the Langmuir layer representation was connected with the theory of ambipolar diffusion. The rigid consideration of the negative and positive charge distributions in the plasma boundary layer, which is formed necessarily before such a wall, leads, under the assumption that the electrons exist even in weak currents still in statistical equilibrium with the (repulsive) field of the wall charge, to a fundamental plasma constant, the quadrate of which specifies the ratio of mean particle energy to mean field energy in the volume unit of an isothermal plasma in the stationary state. It can be calculated exactly with the help of the second Painleve transcendents. Important conclusions are also given for the stationary distribution of the charge carriers in the interior of the plasma. (tr-auth)

27673 EMISSION AND VIBRATION DISTRIBUTIONS OF THE 1ST NEGATIVE GROUP AND THE 2ND POSITIVE GROUP IN A NITROGEN PLASMA. H. H. Broemer and F. Spieweck (Technische Hochschule, Brunswick). Z. Physik, 184: 481-91(1965). (In German)

The intensity of the first negative system of $N_2^+(B^2\Sigma_u^+ - X^2\Sigma_g^+)$ and of the second positive system of $N_2(C^3\Pi_u - B^3\Pi_g)$ was observed in the discharge and in the afterglow as function of discharge current. An a-c discharge in pure nitrogen was used at pressures of about 5 torr. The intensity of the first negative system of N_2^+ — in the discharge and in the afterglow — rises to a maximum and decreases with further increase of the discharge current. The afterglow intensity of the second positive system of N_2 shows a maximum too. In the discharge, however, the intensity of the second positive system of N_2 increases with increasing discharge current. The relative population of the vibrational levels $N_{v'=i}|N_{v'=0}$ (i = 1,2,3,4) of the $B^2\Sigma_u^+$ state of N_2^+, in the discharge and in the afterglow, increases with increasing discharge current, while the relative population of the vibrational levels $N_{v'=i}|N_{v'=0}$ (i = 1,2,3,4) of the $C^3\Pi_u$ state of N_2 reaches a maximum in the discharge. There seems to be evidence that the first negative system of N_2^+ is not excited by electron impact with N_2 molecules in ground state under the discharge conditions in question. (auth)

27674 HIGHLY-RAREFIED PLASMA FLOW OVER A BODY. N. T. Pashchenko. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 5, 3-10(Sept.-Oct. 1964). (In Russian)

Equations are derived for the stationary flow of a highly rarefied plasma about a charged satellite. It is assumed that the characteristic radius of the body is large compared to the Debye radius and that the effect of the small charge on the plasma as a whole is not important. The equations are based on a linearization of the Vlasov equations, which neglect the mutual collision of plasma particles. The velocity of the body is considered to be small with respect to the thermal electron velocity, but large compared to the thermal ion velocity. Cases are considered in which the surface of the satellite is a metal, and in which it is a dielectric. Sample numerical results are presented for the case where the body is an infinite cylinder. In some cases, the drag on the satellite from the electric effects is of the same order as the drag caused by direct collisions of the charged and neutral particles with the satellite itself. (TTT)

27675 DIFFUSION AND CONDUCTIVITY IN THE PARTIALLY IONIZED MULTITEMPERATURE GASEOUS MIXTURE. V. A. Polyanskii. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 5, 11-17(Sept.-Oct. 1964). (In Russian)

Hydrodynamic equations are obtained for energy and mass diffusion in a multicomponent, multitemperature mixture containing ionized particles in an external electromagnetic field. The equations are solved by the method of moments. The Landau form is used for the collision integral for charged particles; the Boltzman form is used for neutral particles. The conductivity and diffusion constants are obtained for a mixture of several kinds of ions. Sample calculations are made for a mixture containing neutrals, ions, and electrons. The temperatures of the neutrals and ions are assumed to be equal and much less than the electron temperature. It is assumed that anisotropic transfers may be neglected. Ambipolar diffusion coefficients are calculated for the mixture. The conductivity also is calculated for a fully ionized plasma with two kinds of ions. Even if anisotropic transfers may not be neglected, the results are still valid for the diffusion coefficients along the magnetic field. (TTT)

27676 ON THE STRUCTURE OF A FLUX IN ELECTRIC DISCHARGE SHOCK TUBES. M. I. Vorotnikova and R. I. Soloukhin. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 5, 138-40(Sept.-Oct. 1964). (In Russian)

Simultaneous measurements were made of the gas pressure and light front from waves in electric-discharge shock tubes to determine the deviation of the properties of the shock waves with Mach numbers above 100 from those calculated by one-dimensional theories. Measurements were made in a rectangular 15 × 50 mm shock tube 160 cm long. The discharge took place in air at a pressure of 0.2 mm. It was found that the velocity front of the luminescent wave exceeds that of the pressure front by 1.6 cm/μsec. Pictures of the contour of the shock wave show that strong boundary lines are absent and that the shock front acts as a semipermeable piston. The measured pressure behind the shock wave was about half that calculated by one-dimensional theories. Reflected and refracted shock waves were observed by colliding two shock waves in a cylindrical tube 27 mm in diameter using a coaxial discharge. The velocity of the reflected wave was higher than calculated values, indicating that the temperature of the gas was only increased by a factor of 1.5, instead of 2.0, as is usually assumed. By measuring the pressure of the shock wave in a cylindrical tube as it passed a concentric cylindrical obstruction, a separate determination could be made of the Mach number. (TTT)

27677 CORRECTIONS DUE TO COMPTON SCATTERING TO THE KINETIC COEFFICIENTS OF A PLASMA IN WHICH THE RADIATION PRESSURE IS LARGE. V. I. Vladimirov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 35: 196-9(Feb. 1965). (In Russian)

The kinetic coefficients are calculated for a plasma in which the electron-photon collision frequency is smaller than the electron-ion collision frequency but is not negligible. The calculations are based on a previously derived form of the kinetic equation for a nonuniform plasma in which electron-photon collisions and the drag of electrons by photons are included. The kinetic equation is solved by expanding the distribution function in a series of Laguerre polynomials in the ratio of the electron drift energy to the temperature, and the kinetic coefficients are calculated to the first order in the ratio r of the electron-photon to the electron-ion collision frequency. When the kinetic coefficients are expressed in the form A(1 – Br), the coefficients B are generally between 1 and 10, and are much smaller than would be obtained by neglecting the electron-electron interaction. In a strong magnetic field (Larmor frequency large compared with the electron-ion collision frequency), the electron-electron interaction is not important and the coefficient B in the expression for the thermo-emf is of the order $(T/hc)^3/n$, where n is the particle density. When the ratio of the electron drift energy to the temperature exceeds the critical value at which electron escape sets in, the electron distribution function acquires a second maximum, leading to instability. (ATD)

27678 STRUCTURE OF WEAK SHOCK WAVES WITH THE ION LARMOR RADIUS TAKEN INTO ACCOUNT. A. D. Pataraya. Zh. Tekhn. Fiz., 35: 200-4(Feb. 1965). (In Russian)

The propagation of an adiabatic shock front moving transversely to a magnetic field in a two-component plasma is treated in the magnetohydrodynamic approximation. The stress in the electron gas is represented by a hydrostatic pressure, but that in the ion gas includes nondiagonal elements due to the anisotropy of the ion velocity distribution.

It is found that when the ion Larmor radius is sufficiently small the properties of the plasma in front of the shock vary monotonically with distance from the shock, while those behind the shock front vary in an oscillatory manner with distance. When the ion Larmor radius is sufficiently large, however, the variation of the plasma properties is oscillatory in front of the shock and monotonic behind it. This change in behavior is due to a change in the dispersion equation; when the ion Larmor radius is large, the velocity of the waves increases with increasing wave number. (ATD)

27679 ON THE STABILITY OF TWO COLLIDING PLASMA STREAMS IN A MAGNETIC FIELD. D. G. Lominadze and K. N. Stepanov (Khar'kov Inst. of Physics and Tech.). Zh. Tekhn. Fiz., 35: 205-11(Feb. 1965).

The stability of two plasma streams of equal density and temperature moving through each other in opposite directions parallel to an external magnetic field is discussed. The following cases are treated separately: 1) low-frequency longitudinal oscillations when the magnetic pressure is large compared with the kinetic pressure, the electron thermal velocity is large compared with the stream velocity, and the ion thermal velocity is negligible; 2) high-frequency longitudinal oscillations when the thermal velocities of both the electrons and ions are small compared with the stream velocity; and 3) oscillations that occur when the ion temperature is high. The dispersion equations are given, and their behavior is illustrated graphically in each case. Stability conditions and equations for the growth constants (logarithmic increments) near the stability boundaries are derived. The instability found in case 1) when the stream velocity is large compared with the velocity of sound could be employed to heat the ion component of a plasma with electrons already at a high temperature. The growth constant of the oscillations in case 3) is small, but these oscillations may still be important in interacting plasma streams because the ions carry the major portion of the stream energy. (ATD)

27680 INVESTIGATION OF THE DRAG OF PLASMA ELECTRONS BY A TRAVELING MAGNETIC WAVE. R. A. Demirkhanov, I. Ya. Kadysh, I. S. Fursa, and Yu. S. Khodyrev. Zh. Tekhn. Fiz., 35: 212-22(Feb. 1965).

The drag of electrons by traveling waves was investigated under steady state conditions in Xe, Kr, Ar, Ne, He, and H_2 plasmas at pressures from 3×10^{-4} to 8×10^{-2} mm Hg. The plasmas were contained in a fused quartz torus and excited by traveling waves produced by a loaded helical delay line wound on the toroidal plasma chamber and fed with an 8 kw oscillator at from 1 to 4 Mc. The phase velocity of the waves ranged from 4×10^7 to 4×10^8 cm/sec. The magnitude of the electron current in the plasma was determined by measuring the magnetic field on the principal axis of the torus with a saturated Permalloy frequency doubling probe. The electron density and temperature and the high-frequency power absorbed by the plasma were also measured. Electron currents as great as 500 amp were obtained for short intervals with the apparatus overloaded. The electron current reached a maximum at a pressure independent of the absorbed power. The velocity of the electrons was nearly equal to the phase velocity of the waves under conditions of maximum current. A simple theory of the phenomenon is developed, and the experimental results are compared with it. Reasonable agreement is found for pressures greater than that for which the current is maximum, but the theory does not account for the current peak observed. This inadequacy of the theory is ascribed to the neglect of the effects of thermal motion and the walls of the chamber. (ATD)

27681 INVESTIGATION OF THE LUMINESCENCE FRONT STRUCTURE IN ELECTROMAGNETIC SHOCK TUBES. Yu. V. Makarov and A. M. Maksimov. Zh. Tekhn. Fiz., 35: 223-5(Feb. 1965). (In Russian)

Experiments were carried out in air and other gases in a shock tube with a conical discharge chamber to investigate the luminescence front, its relation to the shock wave, the extension of the shock-heated gas region, pressure, flow velocity, and the temperature and concentration of charged particles behind the front. The gas pressure was 0.5 to 5 mm Hg and the velocity of the front 3 to 14 km/sec. Photographs showed that the original plane front mushroomed and then separated when the discharge current passed its maximum. The instabilities developing at the luminescence front led to its disintegration. The reflection of the shock wave from the plane face depended on pressure. It was found that the luminescence front was a gas-discharge plasma mixed with impurities from the electrode and the chamber wall material. The plasma stayed close to the shock front at low pressures and high velocities. A distinct shock-heated gas zone appeared at higher pressures. The electron concentration before the front was three orders higher than the calculated equilibrium concentration behind the front, a condition attributed to the presence of heated plasma. (ATD)

27682 IMPEDANCE OF A PLANE CAPACITOR COMPLETELY OR PARTIALLY FILLED WITH PLASMA. (PART II). A. F. Aleksandrov (Moscow State Univ.). Zh. Tekhn. Fiz., 35: 226-34(Feb. 1965). (In Russian)

The impedance of an infinite plane capacitor containing between its plates a plasma of singly-charged ions and electrons is discussed theoretically. The calculations are based on the linearized magnetohydrodynamic equations of motion for the electrons and ions with collisions between charged and neutral particles taken into account. The dispersion equation for longitudinal oscillations is derived, and, with the aid of this and the corresponding plane wave solutions of the equations of motion, the impedance of the capacitor is calculated. The resulting expression is simplified by expansion, retaining only first order terms in the ratio of the ion to electron temperature. The impedance and plasma motion are discussed in detail for the three frequency ranges into which the ion and electron Langmuir frequencies separate the frequency axis. The calculated dependence of the resistive component of the impedance on plasma density in the medium frequency range is in agreement with earlier experimental results. The reactive component in this frequency range can be either inductive or capacitive, depending on the conditions of the plasma, the separation between the plates, and the frequency. It is shown that in the low frequency range the resistive component of the impedance is due to the excitation of ion acoustic waves. (ATD)

27683 MOTION OF A PLASMA JET IN A TOROIDAL MAGNETIC FIELD. G. M. Batanov, M. A. Ivanovskii, and I. S. Shpigel. Zh. Tekhn. Fiz., 35: 242-52(Feb. 1965). (In Russian)

The motion of plasma bursts from a 5 kv spark plasma gun in a magnetic field with strongly curved lines of force was investigated. The inhomogeneous magnetic field was produced at the intersection of two tubes. Longitudinal magnetic fields were maintained in both tubes by solenoids. The bursts from the plasma gun, long compared with the radius of curvature of the magnetic lines of force, behaved as jets. The cross section configuration of the plasma jet in the uniform field region was observed with a luminescent screen. The ion distribution and the total number of ions were measured with screened probes. The electron temperature and electric field were measured with a miniature double probe, and the jet polarization was measured with a hemispherical double grid probe filling the entire cross section of the tube. The electron density near the gun was determined by the microwave cut-off method. In a uniform magnetic field of 4 kOe the electron density at 2 to 8 cm from the gun remained above 10^{12} cm^{-3} for 50 to 80 μsec, and at 18 cm from the gun, for about 13 μsec. The electron temperature was between 5 and 10 ev, the total number of ions in a burst was approximately 5×10^{14}, and the velocity of the leading edge of the jet was 2×10^7 cm/sec. It was found that a small dense core of the jet followed the magnetic lines of force with some accuracy, but that a tongue of plasma was ejected transversely to the field from the outer portion of the jet and along its entire length. The polarization field developed only in the outer region of the jet, and in the core the initial radial electric field was maintained. The velocity with which plasma was ejected

transversely to the magnetic field decreased with increasing magnetic field strength. Providing the side tube with a conducting liner did not result in an appreciable decrease in the polarization of the jet. This is ascribed to the small density of the ion current flowing in the conducting wall. (ATD)

27684 CURRENT DISTRIBUTION IN A COAXIAL PLASMA GUN. I. M. Zolototrubov, V. A. Kiselev, and Yu. M. Novikov. Zh. Tekhn. Fiz., 35: 253-8(Feb. 1965). (In Russian)

The current distribution within a coaxial plasma gun was determined, high-speed streak photographs of the luminosity within the gun were obtained, and the velocities of the plasma bursts issuing from the gun were measured, in order to clarify the mechanism of plasma acceleration within the gun. Hydrogen was admitted to the gun through an opening in the center of the outer electrode, and the gun was fired by a 20 kv discharge of a 12 microfarad capacitor bank. The maximum discharge current was 105 kamp. The current within the gun was measured using a magnetic probe consisting of two identical coils connected in series opposition. The velocities of the ejected plasma bursts were determined by measuring the flight time between two external magnetic probes. When the delay between gas admission and capacitor discharge was small, only one principal current sheet was formed which moved toward the gun mouth at about 1.5×10^7 cm/sec. When the delay was longer, a second current sheet formed nearer the mouth and moved forward much more slowly. The streak photographs revealed an ionized luminous sheet moving in the opposite direction at nearly 10^8 cm/sec. When the delay was greater than 300 μsec, only one burst was observed to issue from the gun, with velocity roughly equal to that of the current sheet (c.1.5×10^7 cm/sec). With shorter delays two bursts were observed, of which one traveled with the velocity of the current sheet and the other traveled up to 7 times more rapidly. It is concluded that the slower plasma burst is accelerated by the magnetohydrodynamic force responsible for the motion of the current sheet. A mechanism in which drift forces in the crossed fields within the gun accelerate the plasma to high velocities is discussed briefly. (ATD)

27685 EFFECT OF A LONGITUDINAL HIGH FREQUENCY CURRENT ON THE STABILITY OF A QUASI-STEADY FILAMENTARY DISCHARGE. I. M. Roife, P. G. Popov, and S. P. Yakovlev. Zh. Tekhn. Fiz., 35: 259-65 (Feb. 1965). (In Russian)

The stabilizing effect of a high-frequency current on a high-current filamentary discharge in a glass tube in hydrogen or argon was investigated. The flat portion of the current pulse, 300 or 500 μsec, was considerably longer than the rise time. Currents up to 10 kamp were investigated and high-frequency (3 or 20 Mc) currents up to 6 kamp were employed. The discharge took place in a longitudinal magnetic field that could be varied from 0 to 3 kOe. The stability of the discharge was observed by means of a Rogovskie belt, magnetic probes, and high-speed photography. In the absence of the high-frequency current the argon discharge was stable at currents below 5 kamp, and the hydrogen discharge at currents below 2 kamp. At higher currents under some conditions of pressure and magnetic field the high-frequency current was observed to have a stabilizing effect. Specifically, in the hydrogen discharge in a 4 cm tube no stabilizing effect was observed at pressures below 2×10^{-2} mm Hg. At pressures from 2×10^{-4} to 5×10^{-4} mm Hg the high-frequency current exerted a stabilizing effect provided a magnetic field of the correct magnitude was present. At higher pressures the stabilizing effect was present even in the absence of a magnetic field. It is suggested that the stabilizing action may be due to the periodic fulfillment of stability conditions in high-frequency resonance radial vibrations of the filament. (ATD)

27686 CONTRIBUTION TO THE THEORY OF THE LOW-VOLTAGE CESIUM ARC. F. G. Baksht and B. Ya. Moizhes. Zh. Tekhn. Fiz., 35: 266-78(Feb. 1965). (In Russian)

The current-voltage characteristics of a hot-cathode low-voltage cesium arc are calculated for density less than 2×10^{12} cm^{-3} and electron temperature below about 1700°K. The high-energy electrons capable of exciting a cesium atom to the first excited state do not acquire a Maxwellian distribution but are simply accelerated by the electric field until they lose energy by exciting atoms. The production of these high-energy electrons is the bottleneck process; once a cesium atom is excited it is rapidly ionized by stepwise excitation. The fundamental equations and boundary conditions are quoted from a previous work in which volume ionization was neglected. The justification of simplifying assumptions is discussed. The calculated characteristic for a cathode temperature of 1700°K is monotonic, the transition from the diffusion regime to the arc discharge being indicated by a rather sharp bend. At lower cathode temperatures a region of instability occurs in which the current is a three-valued function of potential. The surface ionization of cesium at the electrodes is neglected in the calculations. The effect of surface ionization is discussed, and it is concluded that this process can contribute appreciably to the ion current when the cathode temperature is less than 1500°K. (ATD)

27687 ON THE NATURE OF THE POSITIVE CURRENT-VOLTAGE CHARACTERISTIC OF A LOW-PRESSURE ELECTRIC DISCHARGE. V. N. Klyarfel'd and L. G. Guseva (All-Union Electrotechnical Inst., USSR). Zh. Tekhn. Fiz., 35: 306-11(Feb. 1965).

High-voltage discharges in helium and argon between plane carbonized iron electrodes were investigated experimentally, and results for helium at 0.08 mm Hg with 8-cm electrode separation are presented graphically. At low currents the potential remained constant at 4.6 kv, but when the current reached a certain threshold the potential increased, and plasma could be observed in the vicinity of the anode. With further increase of current the plasma layer became thicker and the potential continued to rise. This increase in potential is ascribed to the effective decrease in the length of the discharge gap as more of the interelectrode space becomes occupied by essentially equipotential plasma. The thickness of the plasma at the anode and the potential drop were measured as functions of the pressure for fixed current and electrode spacing. From the resulting curves the ratio of the ion current to the electron current was estimated and found to be small. From this it is concluded that the high-voltage discharge with plasma at the anode and the anomalous glow discharge are qualitatively identical, differing only in the ratio of the ion to the electron current. As this ratio increases the potential drop approaches a limiting value. This is ascribed either to recombination in the negative glow plasma or to a shift of the position of maximum potential in the anode plasma toward the region of the cathode drop. (ATD)

27688 VOPROSY MAGNITNOI GIDRODINAMIKI. IV. (Problems in Magnetohydrodynamics. Volume IV). M. V. Filippov, ed. Riga, Publishing House of Latvian SSR, 1964. 144p.

This collection of articles is issued as a supplement to a previous collection of articles given at Riga on July 2 to 7, 1962. The articles are theoretical in nature, and deal with subjects such as relativistic magnetohydrodynamics (MHD), the stability of shock waves in MHD, the propagation of MHD shock waves from an explosion, non-linear theory of magneto-acoustic waves in a viscous, heat-conducting medium, the behavior of layered plasma waves, the effect of dissipative processes on the damping of weak plasma waves, wave transformation at a plasma boundary in a magnetic field, behavior of a plasma surrounded by a magnetic barrier, convective processes in liquid metals in the presence of a magnetic field, and a nomogram of determining liquid velocity in a tube. Separate abstracts were prepared for twelve of the sixteen articles included. (TTT)

For abstracts of individual papers see: 26510, 26959, 27689, 27690, 27691, 27692, 27693, 27694, 27695, 27696, 27697, and 27698.

27689 SOME PROBLEMS OF RELATIVISTIC MAGNETOHYDRODYNAMICS. V. V. Golosova and I. S. Shishkin. p.5-13 of "Voprosy Magnitnoi Gidrodinamiki. IV." Riga, Publishing House of Latvian SSR, 1964. (In Russian)

The relativistic magnetohydrodynamic equations for plane shock waves are solved by methods similar to those used in the non-relativistic case. The crux of the solution is the use of two coordinate systems: laboratory coordinates and a coordinate system which moves with the front of the shock wave. The decay of shock waves caused by various discontinuities in the gas are considered. For a velocity discontinuity, the gas acts as a piston. The collision of two Alfven waves is given as an example. (TTT)

27690 STABILITY AND EVOLUTION OF SHOCK WAVES IN MAGNETOHYDRODYNAMICS. V. I. Kapman. p.15-22 of "Voprosy Magnitnoi Gidrodinamiki. IV." Riga, Publishing House of Latvian SSR, 1964. (In Russian)

Plane shock waves are studied in a rarefied plasma with a strong magnetic field ($p \ll H^2/8\pi$). Under these conditions, the only dissipative effect from electron-ion collisions is Joule heating. If the plasma is thin enough and the frequency of the perturbation causing the shock wave is of the same order as the ion Larmor radius, the usual conditions of evolution do not occur; and the usual magnetohydrodynamic equations must be modified. Solutions are restricted to Mach numbers close to unity, where perturbation theory can be used. An eigenvalue problem results for the pressure. If this eigenvalue is close to the spatial decay constant of the magnetic field perturbation, the pressure has the form of a potential well. (TTT)

27691 DECAY OF ARBITRARY DISCONTINUITIES IN MAGNETOHYDRODYNAMICS IN PRESENCE OF AN ENERGY EMITTING (ABSORPTION) SURFACE DISCONTINUITY. A. A. Barmin. p.23-32 of "Voprosy Magnitnoi Gidrodinamiki. IV." Riga, Publishing House of Latvian SSR, 1964. (In Russian)

Surface discontinuities in a perfect gas with infinite conductivity and arbitrary magnetic field give rise to sub-Alfven and super-Alfven oscillations which follow the fast or slow shock waves respectively. The discontinuities may also cause fast and slow self-molding waves and reflective and contact discontinuities, as well as the shock waves. Equations are presented for the various kinds of waves. The combinations of waves and discontinuities which may arise under various conditions are shown on diagrams of reduced pressure versus wave velocity. (TTT)

27692 PROPAGATION OF MAGNETOHYDRODYNAMIC SHOCK WAVES CAUSED BY AN EXPLOSION. V. P. Korobeinikov and E. V. Ryazanov. p.33-41 of "Voprosy Magnitnoi Gidrodinamiki. IV." Riga, Publishing House of Latvian SSR, 1964. (In Russian)

Explosive shock waves are considered in planar, cylindrical, and spherical geometries in a low-pressure conducting gas with an initially weak magnetic field $H_1^2 \ll \rho_2 v_2^2$, where ρ_2 and v_2 are the density and velocity of the gas after the explosion. In these cases the magnetic field after the explosion H may be expanded in terms of a parameter $\mu = (\alpha/E_0)^{1/5} r_{20}^{5/2} H_1$, where r_{20} is the shock wave which would occur for $H_1 = 0$, E_0 is the energy density of the explosion, and α is a constant dependent on the dimensions of the system. The system is one-dimensional only for special configurations of H_1 because of the asymmetries of the magnetic field. For a point explosion in spherical geometry, the magnetic field is largest at r_{20} at an angle of 45° to the direction of propagation, where H/H1 = 4. H/H1 decreases as θ approaches 180°. Equations are given for a line explosion in cylindrical geometry, where the conductivity is proportional to $\rho^n p^m$ (p = pressure, n, m = constants). The spherical equations may be applied to cosmic explosions, and the cylindrical and planar equations may be used to describe fast electric discharges in shock tubes. (TTT)

27693 NON-LINEAR THEORY OF MAGNETO-IONIC WAVES IN VISCOUS THERMOELECTRIC CONDUCTING MEDIA. S. I. Soluyan. p.43-9 of "Voprosy Magnitnoi Gidrodinamiki. IV." Riga, Publishing House of Latvian SSR, 1964. (In Russian)

In a plasma pinch, the equation for the vector velocity v of a converging (diverging) magnetic shock wave with amplitude modulation may be written in the form $\mathrm{div}\, v - \alpha v(\partial v/\partial\tau) = \delta(\partial^2 v/\partial\tau^2)$ where α and δ are constants and τ is the time ($\tau = t \pm x/u$) in a coordinate system moving with the shock wave. The solution of this equation depends on an MHD analog to the Reynolds number $Re = [\alpha v(\partial v/\partial\tau)/\delta(\partial^2 v/\partial\tau^2)]$. If $Re \ll 1$, the nonlinear term may be neglected in the first approximation, and the function v_1 thus found is used for the nonlinear term in the second approximation. If $Re \gg 1$, a similar method is used, except that the δ-term is neglected. In this case the amplitude of the diverging wave increases linearly with distance and then approaches an asymptotic value. (TTT)

27694 ON THE BEHAVIOR OF PLASMA WAVES IN A LAYER. M. V. Konyukov. p.51-62 of "Voprosy Magnitnoi Gidrodinamiki. IV." Riga, Publishing House of Latvian SSR, 1964. (In Russian)

Quasihydrodynamic equations are written for plasma waves moving along the z-axis in a plasma with a magnetic field B(z) pointed along the y-axis. The time dependence is of the form $e^{i\omega t}$. The electric field, with components E_x and E_z, is perturbed by the wave. If ω is much larger than the electron Larmor frequency (ω_0), the coupling between E_x and E_z may be neglected. The equations for E_x and E_z are Riccati equations and can only be integrated for special functions for B(z). If $B(z) = B_0$ for $z < 0$, and $B(z) = B_0 e^{-\alpha z}$ for $z > 0$ (α = const.), $E_z = A \exp \pm ikz$ for $z < 0$, and can be expressed in Bessel functions in $e^{-\alpha z}$ for $z > 0$. If B has the value B_1, except in a layer of width d (where $B = B_2$), E_z is in the form $\exp(\pm ik_1 z)$ outside of the layer and $\exp(\pm ik_2 z)$ inside. The two functions are connected by requiring continuity of E_z and dE_z/dz at the boundaries. In a symmetric layer, where $B(z) = B_0 \operatorname{sech}(\alpha z)$, E_z can be written in terms of hypergeometric functions. For certain values of the coefficients, the Riccati equations can be integrated directly. (TTT)

27695 HYDRODYNAMIC MODELS OF A RAREFIED PLASMA WITH ANISOTROPIC VELOCITY DISTRIBUTIONS. G. M. Zaslavskii and S. S. Moiseev. p.63-72 of "Voprosy Magnitnoi Gidrodinamiki. IV." Riga, Publishing House of Latvian SSR, 1964. (In Russian)

The behavior of relativistic plasmas is of interest in astrophysics, accelerator technology, and in the study of Astron-type thermonuclear devices which depend on an envelope of relativistic electrons. The hydrodynamic approximation is applicable in these problems, because in relativistic problems the collision time is long compared to characteristic times for long-range effects. By taking three moments of the relativistic kinetic equations and using Maxwells equations for the field, a set of tensor equations may be derived. Perturbation theory is used to linearize the equations for strong magnetic fields, where the thermal flux along the magnetic field may be neglected. Viscosity tensors are derived for an ionized gas. For relativistic plasmas in which an anisotropic pressure exists, the finite size of the Larmor radius leads to a magnetic viscosity term which stabilizes the plasma against chute instabilities. Equations are presented for an anisotropic plasma in the absence of a magnetic field. (TTT)

27696 EFFECTS OF DISSIPATIVE PROCESSES IN THE DAMPING OF WEAK PLASMA WAVES. V. V. Gozosov. p.73-81 of "Voprosy Magnitnoi Gidrodinamiki. IV." Riga, Publishing House of Latvian SSR, 1964. (In Russian)

Changes in temperature, temperature gradient, viscosity are considered in determining the equations for MHD waves in an ideal plasma (containing ions, electrons, and neutrals) in which ionization, dissociation, and charge exchange processes occur. It is assumed that the changes are small over a wavelength. Either the frequency of the wave is fixed (and real) and a complex wave vector k is found from the dispersion relation, or the wave vector is fixed, and a complex frequency is found, the imaginary part of which describes the decay of the wave with time. Expressions for the change of entropy with time S are found assuming that each component has its own temperature T_j, pressure p_j, charge e_j ($e_n = 0$ for neutrals), mass m_j, and particle density n_j. S is found from the particle fluxes using the Curie theorem and

the Honsager rule. The wave attenuation coefficients are found from $\hat{S}$ with the assumption that the electron and ion temperatures and pressures are the same, that the electron and ion mass densities are equal, and that the neutrals are at rest. Alfven and magnetic shock waves are considered. (TTT)

27697 ON THE PROBLEM OF WAVE TRANSFORMATION AT THE PLASMA BOUNDARY IN A MAGNETIC FIELD. V. M. Kontorovich and I. N. Kulik. p.83-4 of "Voprosy Magnitnoi Gidrodinamiki. IV." Riga, Publishing House of Latvian SSR, 1964. (In Russian)

If it is assumed that the boundary of the plasma is sharp, the MHD approximation fails, since it only holds for small changes in density. However, it can be shown that in the "hot-vacuum" approximation, where $n_2 \ll n_1$, but $n_1T_1 = n_2T_2$ (n = density, T = temperature), the MHD approximation can be used, since the acoustical impedance is small and the plasma wave may be neglected in the vacuum. In going to the vacuum, all of the coefficients go to zero, except for a weak magnetic field. For the thermoelectric and thermomagnetic waves for which the electric and magnetic fields, respectively, are in the plane of the wave, the transformation coefficients are of the same order in the range $1 \ll |\Delta\omega|\tau \ll \tau\omega$, where ω is the wave frequency and τ is the flight time of the electrons. However, the character of the angular dependences is different. In the plasma, F_1 is a flat function on the order of unity, but F_2 in the vacuum has a sharp maximum. Equations are given for the transformation coefficients from plasma waves to electromagnetic waves. (TTT)

27698 BEHAVIOR OF PLASMA CONFINED BY A MAGNETIC BARRIER. N. G. Koval'skii and I. M. Podgornyi. p.85-90 of "Voprosy Magnitnoi Gidrodinamiki. IV." Riga, Publishing House of Latvian SSR, 1964. (In Russian)

Experiments are described which were performed with the magnetic trap "Orekh" with a field formed at the periphery. Theoretically, the plasma is stable with respect to MHD excitations. In the central regions of the trap, densities of 10^{13} to 10^{15} cm^{-3} were obtained with ion and electron temperatures near 10 ev; plasma lifetimes in the trap were 40 to 80 μsec, almost independent of the magnetic field. The magnetic field was provided by 4 coaxial windings, giving a maximum field of 4000 gauss. The diameter of the central vacuum chamber was 1 m. The width of the magnetic slit δ through which the plasma passed into the trap was found to obey the relation $\delta = 2(4r^2 + \pi Dt)^{1/2}$, where r is the electron Larmor radius, D is the plasma diffusion coefficient, and t is time. As the plasma density was decreased from 10^{14} to 10^{11} cm^{-3}, the lifetime increased. (TTT)

27699 PLASMA PHYSICS AND FUSION RESEARCH. A Handlist for Scientists and Technologists. L. S. Francis, comp. (Culham Lab., United Kingdom Atomic Energy Authority, Abingdon (England)). Nov. 1964. 12p. Free (UKAEA).

About 75 references are presented, arranged under the headings elementary introductions, reviews and surveys, textbooks, and standard works. (D.L.C.)

Shielding

Refer also to abstract 27385.

27700 (APEX-700) MEASURED GAMMA SPECTRA BEHIND VARIOUS THICKNESSES OF BERYLLIUM, BERYLLIUM OXIDE, AND LITHIUM HYDRIDE. Paul W. Schreiber (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). June 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 95p. Dep.(mn); $3.00(cy), 3(mn) CFSTI.

Angular gamma spectral data measured behind various thicknesses of beryllium, beryllium oxide, and lithium hydride at the GE-ANPD Source Plate Facility located at Battelle Memorial Institute are reported. Measurements were made with an 8-inch-high by 8-inch-diameter NaI(Tl) scintillation spectrometer. The contract was terminated before the collimated spectrometer was calibrated. However, a tentative method for approximating the response functions from measured data and available Monte Carlo calculations is given. (auth)

27701 (EIR-78) NEUTRON FLUX MEASUREMENTS IN BENT AIR DUCTS THROUGH WATER. Jean-Marie Paratte and Akbar Etemad (Eidgenoessisches Institut fuer Reaktorforschung, Wurenlingen (Switzerland)). Mar. 1965. 17p. Dep.(mn).

Experiments on neutron penetration in bent ducts through water, performed at the swimming pool reactor SAPHIR, are reported. These experiments consist of neutron flux measurements along the axis of the ducts by means of a thermal detector (Dy) and three threshold detectors (Rh, In, and P). The experimental facility and the detector activity measurement techniques are described. Results concerning ducts with two different diameters and two different bend angles are presented. Some comments on these results are given. (auth)

27702 (ORNL-RSIC-7) TABULATED VALUES OF SCATTERED GAMMA-RAY FLUXES IN IRON INTERPOLATED FROM MOMENTS-METHOD CALCULATIONS. D. K. Trubey (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 85p. Dep.; Free(ORNL).

Tables of scattered gamma-ray fluxes in iron that are suitable for integration over source spectra have been generated on the IBM-7090 computer by Lagrangian interpolation of Goldstein-Wilkins moments-method results for point isotropic gamma-ray sources. Values of the fluxes were obtained for a consistent set of scattered gamma-ray energies taken in steps of 0.1 Mev from 0.2 to 1.0 Mev and in steps of 0.25 Mev from 0.25 to 10 Mev. One table was obtained for each scattered energy for various values of the source energy and of the distance from the source in mean free paths. Tables were then generated in which the distance from the source was converted from mean free paths to centimeters. The latter set may be integrated over any source spectrum to obtain the flux of scattered gamma rays in iron and, with small error, in any material in which the cross section is similar. (auth)

27703 (ORNL-TM-977) RAPID COMPUTATION OF SPECIFIC ENERGY LOSSES FOR ENERGETIC CHARGED PARTICLES. R. W. Peelle (Oak Ridge National Lab., Tenn.). Sept. 1964. Contract W-7405-eng-26. 21p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A method is demonstrated for computing rapidly in a digital computer the specific energy loss of energetic charged particles, excluding electrons. For energies larger than an empirically determined cutoff TLIM, the computation is based on use of the usual Bethe-Bloch equation with a "shell correction" for nonparticipation of tightly bound electrons in the absorber atoms, but without a "density effect" correction which might be required for incident proton energies as high as 1 Bev. Rapid computation is achieved by interpolating a combined shell correction from a small table of values stored with the set of parameters peculiar to a given absorber material. The accuracy is limited to a few tenths of a percent by the coarseness of the interpolation procedure and by the accuracy of the combined shell corrections presently available to serve as a base for interpolation. For incident energies less than TLIM, a plausible value is computed based wholly on a few empirical parameters. The results are compared against published tabulations of specific energy loss and against a very small selection of experiments on relative energy loss and range. A computer subprogram which utilizes the described technique is listed in the IBM-7090 FORTRAN-II language, and brief instructions for its use are given. (auth)

27704 (PAN-556/IA) THE STOPPING POWER OF D_2O FOR LOW-ENERGY PROTONS. E. Rurarz (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research). Oct. 1964. 21p. Dep.

The stoping power of D_2O for low energy protons (18–550 kev) is calculated using a method introduced by M.

Gryzinski. This theory gives very good agreement with the experimental results of Reynolds et al., Phillips and Wentzel, and Whaling. (auth)

27705 (XDC-59-10-69) DATA REPORT AND ANALYSIS OF MEASUREMENTS MADE IN WATER BEHIND ARRAYS OF LiH AND Li^6H. A. W. Casper (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). Oct. 9, 1959. Contract AT(11-1)-171. 34p. Dep. (mn); $2.00(cy), 1(mn) CFSTI.

The fast neutron dose rates, the gamma dose rates, and the thermal neutron flux measurements made in water behind arrays of LiH and ^{6}LiH are presented. The measurements were made in the pool at the GE-ANPD Source Plate Facility at Battelle Memorial Institute. Fast neutron dose rates, gamma dose rates, and thermal neutron flux measurements behind equal thicknesses of LiH and ^{6}LiH are compared. The effect of varying the LiH and ^{6}LiH thicknesses are also presented. Point kernel programs were used to compute the fast neutron and gamma dose rates and these values are compared with the measurements. (auth)

27706 GAMMA-RAY SHIELDING PROPERTY, STRENGTH AND WORKMANSHIP OF BUILTUP TYPE LEAD SLAB STRUCTURE. Toshio Sakai and Mamoru Tanaka (Hitachi Shipbuilding and Engineering Co. Ltd., Tokyo). Hitachi Zosen Giho, 25: No. 4, 24-32(Nov. 1964). (In Japanese)

A full-size builtup type lead slab structure was constructed as part of the secondary shielding for the marine nuclear reactor. Studies of the workmanship indicate that no complicated geometrical forms were needed to form the joints; a simple flat surface was convenient and practical from the points of view of both shielding and strength. Studies of local deformation of the slabs and the bolts due to vibration showed that the structure could unquestionably withstand the vibration of the ship. Semi-experimental formulas for the approximate calculation of leakage of gamma rays at bolted joints were derived. (A.G.W.)

27707 RADIATION STREAMING THROUGH DUCTS AND VOIDS IN SHIELDS. F. W. Krueger and U. E. Michaelis (VEB Atomkraftwerk, Berlin). Kernenergie, 8: 137-62(Mar. 1965). (In German)

Discussion is presented on: radiation streaming through irregularities in a shield; radiation streaming through straight ducts; straight empty ducts; collimators and beam holes; partially penetrating ducts; material-filled ducts; radiation streaming through bent ducts; shielding labyrinths; stepped ducts; helical ducts; and radiation streaming through voids including single voids and distributed voids in the shield. 128 references are included. (P.C.H.)

Solid State Physics

See also CHEMISTRY — Inorganic and Physical Chemistry
METALS, CERAMICS, AND OTHER MATERIALS — Properties and Structure

Refer also to abstracts 26386, 26388, and 27105.

27708 (AD-607786) KNIGHT SHIFT AND NUCLEAR RELAXATION TIMES IN LIQUID GALLIUM (thesis). David Allan Cornell (California Univ., [Berkeley]). June 1964. 72p. $3.00(CFSTI).

The Knight shift in pure liquid gallium was measured as a function of temperature between 300 and 740°K and obeys the empirical relation for change with temperature, $\Delta K = -(2.95 \pm 0.15) \times 10^{-7} (T - 300)$. The shift varies only slightly with volume according to the expression $K(V) = 0.00449\ (V/V_0)^{-0.1 \pm 0.1}$ at pressures between 1 and 5000 kg/cm. The pressure results disagree with the free electron model, and the intrinsic temperature dependence of K, coupled with the theory of Benedek and Kushida, suggests that the s-electron probability density at the nucleus, P_F, decreases with negative curvature as a function of volume. The nuclear spin-lattice relaxation time, T_1, and spin-spin relaxation time, T_2, are measured from 270 to 470°K. $T_1 = T_2$ at 298°K to within 5%. The first results are in good agreement with the theory of Korringa for magnetic relaxation by electrons, when the theory is modified for correlation and exchange as described by Pines. The results are thought to be consistent with a bonded pair or group model of the liquid, whose lifetime is 10^{-13} sec or less. (auth)

27709 (GA-5734) A PROGRAM OF BASIC RESEARCH ON MECHANICAL PROPERTIES OF REACTOR MATERIALS. Annual Summary Report for the Period Ending October 31, 1964. R. H. Chambers, T. A. Trozera, and J. L. White (General Atomic, San Diego, Calif.). Jan. 15, 1965. Contract AT(04-3)-167. 100p. Dep.(mn); $3.00(cy), 3(mn) CFSTI.

Transmission electron microscopy of Ta single crystals deformed to large strains did not show a cell structure unless the deformed crystal was heated in an oxygen atmosphere prior to thinning. No difference was observed between as-rolled crystals and those given a thermal treatment without oxygen. The results indicate that the oxygen pins the dislocations and/or modifies their structural arrangement. It was not possible to isolate the mechanism. Tungsten single crystals of very high purity were prepared from vapor-deposited stock by electron-beam floating-zone melting. Additional purification was attempted by solid-state extraction, with inconclusive results, and by electrotransport, which appeared quite successful. Methods of acoustical spectroscopy and high-amplitude modulus-defect measurements were applied to the study of the mechanical state of a metal. From the studies it appears that the motion of dislocations in the bcc transition metals is controlled by thermally activated processes possessing an energy spectrum with a number of broad bands. There is evidence that the activation energy of some of these bands may be reduced by the application of stress, i.e., that the thermal activation event may be stress-assisted. Furthermore, the highest energy process appears to possess the largest rate of energy reduction by stress or activation volume. Measurements of the stored-energy release on annealing specimens of irradiated and cold-worked Mo were performed. Two important release peaks were found in the irradiated specimens, in the vicinities of 200 and 700°C, and the more highly irradiated specimens show possibilities for additional annealing peaks. (auth)

27710 (KR-93) ADVANCED COURSE ON MAGNETIC EXCHANGE INTERACTIONS IN TRANSITION METAL COMPOUNDS. Organized by the Netherlands'-Norwegian Reactor School at Institutt for Atomenergi, Norway, September 14-18, 1964. (Institutt for Atomenergi, Kjeller (Norway)). 237p. Dep.(mn).

A series of 17 lectures is presented on neutron diffraction and resonance studies of magnetic exchange interactions in transition metal compounds. Among the topics covered by the lectures are ordering schemes in magnetic compounds, Heisenberg hamiltonian, ligand field theory, magnetic electrons, and spin ordering. (D.L.C.)

27711 (UCRL-7497) THEORY OF COUPLED-MODE LASER OSCILLATIONS. J. A. Fleck, Jr. and R. E. Kidder (Lawrence Radiation Lab., Univ. of California, Livermore). Apr. 8, 1964. Contract W-7405-eng-48. 33p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A set of general equations describing the time-dependent behavior of a laser is derived. The derivation is based on a density matrix description of the occupation of a pair of homogeneously broadened laser levels and a semi-classical treatment of the radiation field, consisting of an arbitrary number of modes. The resulting equations resemble ordinary rate and energy conservation equations but contain additional interference terms which, in general, couple all of the modes. The strength of this coupling depends on the inhomogeneity of the population inversion as well as on the mode frequencies. The energy conservation equations imply that absorption and stimulated emission in such a system can apply, strictly speaking, only collectively to the system of modes as a whole. Stability analysis carried

out in the two-mode case indicates that a spatial inhomogeneity in the pumping rate is required for undamped oscillations. It is also concluded that coupling of off-axis modes is more likely to lead to undamped spiking than coupling of axial modes. (auth)

27712 MATERIALY XII SOVESHCHANIYA PO LYUMINESTSENTSII (FIZIKA LYUMINESTSIRUYUSHCHIKH IONNYKH KRISTALLOV) (L'VOV, 30 YANVARYA–5 FEVRALYA 1964 G.). (Report on 12th Conference on Luminescence, held in L'vov, USSR, Jan. 30–Feb. 5, 1964). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 1-92(Jan. 1965). (CONF-640106)

Eighteen papers are included; separate abstracts were prepared for all. (M.J.T.)

For abstracts of individual papers see: 26386, 26387, 26388, 27713, 27714, 27715, 27716, 27717, 27718, 27719, 27720, 27721, 27722, 27723, 27724, 27725, 27726, and 27727.

27713 THE METHOD OF ELEMENTARY SITE EXCITATIONS IN THE THEORY OF NONMETALLIC CRYSTALS. A. E. Glauberman. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 4-9(Jan. 1965). (In Russian)

A review is given of recent work on development of the method of lattice site excitations of nonmetallic crystals, based largely on the work of S. V. Vonsovskii and coworkers. In the variation of the method considered, orthogonalized quasi-atomic local functions are used as the basic system of second quantization functions. A unified description in terms of site excitations can be given of excitations involving current carriers, spin excitations, Frenkel (tightly bound) excitons, Mott (weakly bound) excitons, etc. The topics discussed include formulation of the site excitation operators derived from Fermi operators, distinguishing the ground state, the closed spin system background, model of the non-spin-closed background, effect of an external magnetic field, Vanier-Mott excitons, and phonons and their interactions. (ATD)

27714 PHYSICAL PROCESSES IN LUMINESCING IONIC CRYSTALS. Ch. B. Lushchik. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 10-18(Jan. 1965). (In Russian)

A review is given discussing work on the physical processes in luminescent storage. Detailed investigations were carried out of the physical processes involved in the direct excitation of luminescence centers, the migration of these excitations, and the role of the simplest electron excitations of the host material; investigations were extended to high-energy electron excitations, and considerable work was done in the vacuum ultraviolet to 21 ev and with electrons of energies to 5 kev. A spectral-kinetic method of investigating the kinetics of luminescence phenomena in time intervals from 10^{6} to 10^{-6} sec was developed. Many of the findings of the Tartu group are mentioned with reference to the original publication, and some are discussed briefly and illustrated with absorption spectra of indium or silver activated alkali halide crystals. The sequence of events involved in radioluminescence is conceived as follows: the initial x or γ ray produces a photoelectron or a Compton electron which in turn gives rise to a cascade of secondary electrons. The secondary electrons give rise to short-lived electron excitations, which are transformed into stable electron excitations. These excitations are trapped by impurity centers which, after intermediate internal processes, produce luminescence. Further experiments, particularly in the relatively unexplored energy region from 20 to 1000 ev, are required to determine how well the concepts developed reflect the complex physical phenomena in ionic crystals. 53 references. (ATD)

27715 ON COLOR CENTERS AND RECOMBINATION LUMINESCENCE IN ALKALI HALIDE PHOSPHORS. I. A. Parfianovich and E. I. Shuraleva (Irkutsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 19-26(Jan. 1965). (In Russian)

A review is given, emphasizing the complexity of the processes involved and the incompleteness of present knowledge. This is illustrated by a brief discussion of F centers in NaCl : Cu and NaCl : Ni. It is shown that although the recombination processes in these materials are of the same sign, different physical mechanisms are involved in the two cases. It is concluded that photoluminescence involves a number of intermediate processes for the understanding of which further experiments involving both optical and electrical techniques will be required. 102 references. (ATD)

27716 TRANSFORMATIONS OF ELECTRON EXCITATIONS IN IONIC CRYSTALS. E. R. Il'mas, R. A. Kink, G. G. Liid'ya, and Ch. B. Lushchik (Inst. of Physics and Astronomy, Academy of Sciences, Estonian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 27-35(Jan. 1965). (In Russian)

The reflection spectra from the (100) surfaces of eight alkali halides were measured to a quantum energy of 14 ev with a vacuum monochromator, and the results are presented graphically. These spectra show numerous peaks above a relatively smooth background; the peaks in the long wavelength portion of the spectra are characteristic primarily of the anion, and those in the short wavelength region, of the cation. The energies of the short wavelength peaks are close to the minimum excitation energies of the free cations. The excitation spectra of the stationary activator luminescence for a number of ionic crystals activated with In or Tl were measured by methods described previously. The quantum efficiencies were obtained by correcting for incomplete absorption and selective reflection, and the results for several alkali halides are presented graphically. Three regions can be distinguished in the KCl and KBr spectra, in each of which the quantum yield is approximately constant: the region of activator absorption, the longest wavelength exciton absorption band, and a broad region extending to about 14 ev in the chlorides. In several iodides an increase in quantum yield was observed at excitation energies above 10 or 12 ev. This is ascribed to a photon multiplication process. These experimental data are discussed in some detail in connection with other material in the literature. The final results are found to be the same whether the ionic crystal is excited by high energy photons or by low energy ones. It is concluded that the high energy excitation is rapidly transformed into simple excitons and electron-hole pairs. (ATD)

27717 · SELF-TRAPPING OF HOLES AND OPTICAL PHENOMENA IN IONIC CRYSTALS. G. K. Zolotarev, Ch. B. Lushchik, T. A. Soovik, I. V. Yaek, and M. A. Elango (Inst. of Physics and Astronomy, Academy of Sciences, Estonian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 36-9(Jan. 1965). (In Russian)

A brief review of recent work concerning the role of hole self-trapping in optical phenomena, specifically in recombination luminescence, roentgenoluminescence, and radiation coloring is given. The effect of self-trapping is to suppress the phenomena at low temperatures, where self-trapping occurs. Recombination luminescence is illustrated with absorption and glow curves. Photoluminescence of KCl : Ag after x irradiation at 100°K was found to be small until the material was heated above 200°K; thereafter the photoluminescence was large even after subsequent cooling to 100°K; this behavior is explained by the thermal release of self-trapped holes. An intense thermoluminescence peak for KCl : AgI at 220°K is ascribed to recombination of holes with electrons trapped in $Ag^{+}I$ centers and is regarded as the first convincing case of hole recombination luminescence at activator centers in ionic crystals. Further investigation is desirable to determine whether anion excitons may also become self-trapped in ionic crystals at low temperatures. (ATD)

27718 ON SOME PECULIARITIES OF THE RADIOLUMINESCENCE OF ALKALI HALIDE CRYSTAL PHOSPHORS. G. A. Mikhal'chenko. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 40-2(Jan. 1965). (In Russian)

Beta-ray excited radioluminescence of NaCl, KCl, and KBr based phosphors activated with Ag, Tl, or In was investigated at temperatures from 250 to –150°C. A fast component with a decay time less than 0.001 sec and a

slow component with a decay time of the order of 0.01 sec were observed. The behavior of the fast component was relatively independent of the temperature, but the slow component was strongly temperature dependent, being very weak or absent at low temperatures. When the phosphor was irradiated at a low temperature, heated in the absence of beta radiation, and subsequently cooled, further gamma irradiation excited strong luminescence. It is suggested that beta irradiation produces centers which do not directly give rise to luminescence but which transform under thermal activation into centers of a second type which do luminesce when stimulated by beta radiation. It is suggested that these centers are due to build up of electrons and holes lodged at lattice vacancies. Data pertaining to sixteen phosphors are tabulated; the thermal behavior is characteristic of the host crystal and nearly independent of the activator. (ATD)

27719 ROENTGENOLUMINESCENCE AND OPTICAL FLASH IN A NaCl: Ni PHOSPHOR. I. A. Parfianovich, V. G. Krongauz, and E. I. Shuraleva (Irkutsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 43-5(Jan. 1965). (In Russian)

Roentgenoluminescence and optical flash stimulated by radiation in the F absorption band were investigated in a NaCl: Ni phosphor. The intensity of the F-stimulated flash in a phosphor irradiated with x rays at −160°C increased in a stepwise manner with temperature to a maximum at 80°C and decreased smoothly to zero with further increase of temperature. It is hypothesized that the charge on the Ni^{2+} ions, to which the recombination luminescence is due, is reduced by x irradiation and that the activator ions recover their double charge when the material is heated. This hypothesis is supported by further experiments in which a striking parallelism was disclosed between the variations of optical flash and roentgenoluminescence intensities under the influence of both thermal and optical treatment. (ATD)

27720 PHOTOSTIMULATED RECOMBINATION LUMINESCENCE IN ACTIVATED ALKALI HALIDE CRYSTALS. M. F. Okk and I. V. Yaek. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 46-9(Jan. 1965). (In Russian)

The stimulation spectrum for optical flash in a KCl: Tl phosphor irradiated with x rays at 100°C was measured to quantum energies of about 4 ev. Four stimulation bands were found, of which two coincided with the F and K absorption bands and the other two, at 1.85 and 3.3 ev, did not coincide with any known absorption bands. A previously unknown stimulated absorption band at 3.3 ev was found, however, in strongly irradiated KCl: Tl but not in KCl: In. Irradiation of the phosphor with 1.85 ev photons led to decrease in the intensity of the 3.3 ev band and to increase of the absorption in the F band. The temperature dependence of the intensity of optical flash triggered by 3.3 ev photons was found to be similar to that of optical flash stimulated by F band radiation; in particular, the intensity was found to increase rapidly with temperature in the region near 220°K where self-trapped holes are released. In this temperature region the absorption of 3.3 ev photons decreased with increasing temperature. It is concluded that the activator centers involved are electronic and it is hypothesized that they are atomic Tl^0 centers analogous to the E centers in KCl: Ag. Optical flash stimulated by radiation in the hole bands was not found. (ATD)

27721 LUMINESCENCE OF IONIC CRYSTALS UNDER THE ACTION OF ELECTRONS. T. I. Eksina. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 50-3(Jan. 1965). (In Russian)

Thermoluminescence of Tl and In activated NaCl and KCl phosphors pre-excited by 50- to 5000-ev electron bombardment or irradiation with 6- to 21-ev photons was investigated. Bombardment was with single pulses with 1 μsec rise time and 40 to 400 μsec duration. Glow curves of phosphors stimulated by electrons and photons are presented. The curves for stimulating at photon energies greater than 10 ev or electron energies less than 250 ev are practically the same. This is regarded as support for the hypothesis that high-energy electron excitations rapidly decay to simple electron excitations such as those directly produced by low-energy photons. The pecularities of the glow curves obtained with photon energies below 10 ev are ascribed to the greater penetration of these photons and to the peculiarities of the low-energy luminescence mechanism itself. The peculiarities of the glow curves obtained with high-energy electrons are ascribed to the fact that in these cases the electron current was two orders of magnitude greater than that for slow electrons. (ATD)

27722 INVESTIGATION OF THE DETAILED MECHANISM OF RECOMBINATION LUMINESCENCE OF NaCl: Ag CRYSTAL PHOSPHOR. Yu. L. Lukantsever, F. N. Zaitov, and V. P. Chernenko (Osh State Pedagogical Inst., Kirgiz SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 54-8 (Jan. 1965). (In Russian)

An investigation was made of the last three stages of phosphorescence of NaCl: 0.2 mole % Ag crystal phosphor, to clarify the details of the recombination luminescence mechanism. The three stages are released of the stored excitation energy, transfer of the energy to luminescence centers, and emission from the centers. The phosphor was excited by x rays from a BSV-2 x-ray tube with a copper anode. The energy storage was studied with reference to additional absorption spectra recorded by a spectrophotometer. The steady-state emission and the phosphorescence spectra are shown at different intervals after cessation of excitation. The integral thermostimulation and thermobleaching curves and the spectra of thermostimulated emission at different temperatures (different stages of the relaxation process) are given. The possible luminescence mechanisms are discussed; a similarity of the steady-state luminescence and thermostimulated luminescence spectra indicates that the same centers are involved. A pumping mechanism is considered, involving trapping of electrons from the conduction band to form excited centers of induced emission; this mechanism is thought to have several advantages over earlier hypothesized methods of excitation. (ATD)

27723 ON THE LUMINESCENCE OF "PURE" ALKALI HALIDE CRYSTALS. I. A. Parfianovich, E. I. Shuraleva, and V. G. Krongauz (Irkutsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 59-62(Jan. 1965). (In Russian)

The luminescence of pure NaCl and KCl crystals of different origin was examined to obtain a basis for judging whether pure crystals can be luminescent. All the crystals exhibited photoluminescence when excited by 200 to 300 millimicron radiation. The luminescence was weakest, however, in those crystals in the growth of which the greatest care was taken to eliminate impurities, and the excitation spectra of the different crystals differed considerably. Emission characteristic of copper-activated materials was observed in most of the crystals, and the presence of copper (and some other impurities) was spectroscopically demonstrated in all of them, including natural crystals. Glow curves following x-ray excitation were recorded. These differed considerably in the position and relative intensity of the peaks and the light sum stored after identical excitation. It was concluded that luminescence and tenebrescence in pure alkali halide crystals must be ascribed to the presence of residual impurities. The possiblity that so-called α-luminescence may occur in pure materials, however, is not excluded. (ATD)

27724 INVESTIGATION OF THE PROPERTIES OF SINGLE CRYSTALS OF SOLID SOLUTIONS OF ALKALI HALIDE COMPOUNDS. E. K. Zavadovskaya (Tomsk Polytechnic Inst., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 63-7(Jan. 1965). (In Russian)

A brief review is given of data concerning the properties of single crystals of solid solutions of alkali halides. The topics mentioned include type of defects, F center concentration, heat of formation (solution), stopping power for beta rays, electric conductivity, dielectric loss, dielectric strength, microhardness, friability, and effects of irradiation with protons, neutrons and x rays. It is concluded that the greatest difficulties in this area of research are due to insufficiently pure materials, that the properties of different solid solutions should be compared under con-

ditions of equal ratio of temperature to either Debye temperature or melting temperature, and that techniques of metal-alloy investigation should be applied to the investigation of alkali-halide solid solutions. (ATD)

27725 SOME EFFECTS OF INTERACTION OF X RADIATION WITH NaI(Tl) CRYSTALS AND THEIR BEARING ON THE SPECTROMETRY OF SCINTILLATION DETECTORS. Ya. M. Zakharko and V. V. Chepelev (L'vov State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 78-81(Jan. 1965). (In Russian)

A study was made of decay of roentgenoluminescence and x-ray effects on the scintillation behavior of plates cleaved from NaI(Tl) single crystals. The thallium-doped sodium iodide crystals were grown by the Kyropoulos technique, cleaved, enclosed in aluminum containers with a glass window, and irradiated with square 150 μsec x-ray pulses, at intervals of about 2000 μsec. The crystals with good spectrometric (energy) resolution had no slow afterglow component; those with poor resolution exhibited a pronounced slow component (100 to 200 μsec) in the decay of their roentgenoluminescence. Initially good detector crystals after rough mechanical treatment of their surface begin to exhibit a slow component. It is inferred that the slow component is associated with the presence of structural imperfections; this inference is substantiated by the results of temperature studies (heating heals the defects). No correlation between the thallium content and the decay time of the slow component was found. The growing atmosphere does not appear to be significant, but factors such as the rate of growth and subsequent rate of cooling seriously affect the spectrometric qualities of NaI(Tl) crystals. Prolonged irradiation gives rise to structural imperfections (mainly anionic vacancies) with resultant deterioration of the detector characteristics. The recovery time depends on the dose or exposure time at a fixed level. In general, by virtue of self-diffusion, recovery is fairly rapid: some 2-3 hours after irradiation for under 1 min at 300-350 r/min. (ATD)

27726 CHANGES IN THE ELECTRIC PROPERTIES OF ALKALI HALIDE CRYSTALS UNDER PROLONGED APPLICATION OF A D-C FIELD. M. N. Popova, G. B. Semushkin, and A. N. Tsikin. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 82-5(Jan. 1965). (In Russian)

The aging of KCl and KBr crystals in fields from 50 to 1000 v/cm was investigated at 350 to 650°C. Metal foil electrodes were carefully attached to the crystals, and the contact was considered satisfactory provided no trace of oxidation of the electrode could be seen after the experiment. The current versus time curves showed four distinct regions: an initial region of constant current, a region of rapidly increasing current, another region of nearly constant current, and a final region of rapidly increasing current leading to breakdown. All four regions of the current curve were clearly marked in the case of the KBr crystals, and tenebrescence was either absent or very weak. When tenebrescence was observed it appeared simultaneously throughout the crystal with no trace of tenebrescence front. With the KCl crystals only the first three regions of the current curve were ordinarily observed, and these were less sharply distinguished than in the case of KBr. Tenebrescence was regularly observed but different crystals behaved differently in this respect. In some crystals the coloring appeared simultaneously throughout the crystal as in KBr, and in others a region containing a considerable concentration of F centers formed at the cathode and grew toward the anode. Discharge currents decaying slowly with time were observed with all crystals when the aging was interrupted at any stage and the electrodes short circuited. Some of the results can be interpreted in terms of the electrolytic theory of Heiland; it is suggested that two processes are involved, one of which is described by Heiland's theory, while the other requires further study. (ATD)

27727 CONCERNING THE NATURE OF LUMINESCENCE CENTERS IN ALKALI HALIDE CRYSTALS. F. D. Klement. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 86-92(Jan. 1965). (In Russian)

The role of the activator ion in alkali-halide luminescence centers is discussed, considering whether the ion retains its individuality in the host lattice or forms some sort of molecule and whether the ion is located at a regular cation site, at defects, or on the surface of microblocks. The luminescence-center model proposed by Konstantinova-Shelzinger, in which the activator ion forms a quasimolecule consisting of the ion and surrounding anions, is characterized briefly. The model of Ivanova and coworkers is described, in which the center is either a simple activator halide molecule or a more complex molecule. Experimental evidence is found to be against the center being a molecule or quasimolecule. The view of Shamovskii, that the centers are formed by activators located on the internal surfaces of microblocks, is discussed. Arguments in favor of the concept held by the Tartu group are adduced; in this view the centers are formed by ions (not molecules) lodged at sites of the host lattice, the crystal phosphor is a true solid solution of the activator in the host compound, and the luminescence spectrum is due to electron transitions between the levels of the ion, deformed by the field of the crystal lattice. Thus, basically the core of each luminescence center in alkali halide phosphors is an activator ion, and the difference between different types of luminescence centers is due mainly to the different effects of the neighboring ions. (ATD)

27728 LOCATION OF THE SOURCE OF RECOMBINATION RADIATION IN $Ga(As_{1-x}P_x)$ p-n JUNCTIONS BY ELECTRON BOMBARDMENT. C. M. Wolfe (Univ. of Illinois, Urbana), M. D. Sirkis, C. J. Nuese, N. Holonyak, Jr., O. L. Gaddy, O. T. Purl, and W. E. Kunz. J. Appl. Phys., 36: 2087(June 1965).

A problem of considerable interest concerning p-n junction lamps and lasers is the determination of the location in or near the junction of the injected carriers and, hence, of the source of the subsequent recombination radiation. By means of free electron bombardment of polished rectangular $Ga(As_{1-x}P_x)$ samples containing p-n junctions, it was shown that it is carrier injection and recombination on the p side of the junction that plays a dominant role in junction luminescence. (C.E.S.)

27729 MODULATION OF THE OPTICAL ABSORPTION OF F CENTERS IN KCl. G. Ascarelli and A. Barone (Istituto Nazionale di Ultracustica, Rome). Nuovo Cimento (10), 37: 818-23(June 1, 1965).

An experiment is described in which the optical absorption of the F band of a KCl crystal is modulated by means of an ultrasonic strain. If the description of the effect is based on the usual configurational coordinate model, the amplitude of the energy modulation of the optical transition is equal to $k_e x_0 a\epsilon = 3.8\ \epsilon$ ev, where ϵ is the uniaxial strain along one of the principal crystal axes, k_e and x_0 are constants describing the excited electronic state in the configurational coordinate model and a is the lattice constant. (auth)

27730 LONGITUDINAL MAGNETORESISTANCE OF PURE ALUMINUM WIRES. O. S. Lutes and D. A. Clayton (Honeywell Research Center, Hopkins, Minn.). Phys. Rev., 138: A1448-52(May 31, 1965).

The longitudinal magnetoresistance was investigated for aluminum wires having purity sufficient to make boundary scattering observable. Measurements were made at 4.2°K using fields up to 13 kOe. Wire diameters were in the range 0.005–0.05 cm. As expected, the magnetoresistance becomes increasingly negative at smaller diameters. In order to analyze the data, the normal positive magnetoresistance was taken into account by means of a modified Kohler's rule suggested by Olsen. By use of the free-electron theory of Chambers the mean free path l, electron momentum p, and the product of mean free path by resistivity lp, were obtained for each wire. The average $p/\hbar$ was found to be $1.0 \pm 0.2 \times 10^8\ cm^{-1}$. This result was compared with wave numbers expected for central orbits of the approximate second-zone Fermi surface. It was found to correspond most closely to the (111) orbit, consistent with the preferred grain orientation in the wires. The lp result, interpreted according to

the free-electron relation, gives a surface area about $^2/_3$ that predicted for the second-zone surface. (auth)

27731 TEMPERATURE AND FIELD DEPENDENCE OF HYPERFINE FIELDS AND MAGNETIZATION IN A DILUTE RANDOM SUBSTITUTIONAL FERROMAGNETIC ALLOY: $Fe_{2.65}Pd_{97.35}$. P. P. Craig (Brookhaven National Lab., Upton, N. Y.), R. C. Perisho, R. Segnan, and W. A. Steyert. Phys. Rev., 138: A1460-71(May 31, 1965). (BNL-8733)

The assumption of proportionality between hyperfine magnetic field and bulk magnetization, which has been shown to obtain in elemental ferromagnetic Fe, is shown to apply as well in the random substitutional cubic dilute ferromagnetic alloy $Fe_{2.65}Pd_{97.35}$. The same sample of this alloy was studied by means of both the Mössbauer effect and bulk magnetization. The Mössbauer data represent the first detailed study of the hyperfine field in a ferromagnet in the presence of large external fields. Proportionality between the bulk magnetization and the hyperfine field is found over an extended range of temperature and applied external magnetic field. Extrapolations of the bulk-magnetization data to yield the Curie point disclose significant discrepancies with the Mössbauer results when standard extrapolation techniques are used. Good agreement is obtained if one assumes that the magnetization varies near the Curie temperature θ as $(\theta - T)^{\beta}$ with β between $^1/_4$ and $^1/_3$. This type of behavior suggests that the sample may be describable in the region of the Curie temperature by recent Padé-approximant calculations based upon Ising and Heisenberg models. The temperature variation of the hyperfine field is compared to molecular-field calculations in both zero and nonzero external fields. Although qualitative agreement is found, there are significant quantitative discrepancies, indicating the inapplicability of the molecular-field model. A description is included of the Brookhaven cryogenic Mössbauer apparatus involving a variable-temperature cell mounted inside a high-field superconducting magnet. (auth)

27732 MAGNETIC PROPERTIES OF HEAVY RARE EARTHS DILUTED BY YTTRIUM AND LUTETIUM. H. R. Child, W. C. Koehler, E. O. Wollan, and J. W. Cable (Oak Ridge National Lab., Tenn.). Phys. Rev., 138: A1655-60 (June 14, 1965). (ORNL-P-951)

A neutron-diffraction study of the heavy rare earths Tb, Dy, Ho, Er, and Tm diluted with yttrium and of Tb with lutetium is reported. The modulated antiferromagnetic structures of the rare-earth metals are found to exist in the alloys, but the ferromagnetic phases of Tb and Dy are destroyed with small admixtures of Y. The Néel temperatures of the alloys and the pure metals are found to be a universal function of the average of the square of the spin projection on J, given for these heavy-rare-earth alloys by $\xi = c(g-1)^2 \times J(J+1)$, where c is the atomic concentration of rare earth. The value of the interlayer angle ω at T_N which is related to the wavelength of the modulation of the magnetic structure is also found to be a universal function of ξ, and the temperature variation of ω decreases with decreasing ξ so that ω approaches a temperature-independent value of about 50° per layer for small ξ, regardless of the magnetic ion in the alloy. (auth)

27733 SOME THERMOEMISSIVE PROPERTIES OF POLYCRYSTALLINE RHENIUM. E. Ya. Zandberg and A. Ya. Tontegode (Ioffe Inst. of Physics and Tech., Leningrad), Zh. Tekhn. Fiz., 35: 325-31(Feb. 1965). (In Russian)

The thermoelectric emission of Re and the ionization of In, Ca, Ag, and Mg on a rhenium surface were measured. Rhenium wires 0.1 mm in diameter, annealed at 1800°K and flashed for an hour at 2500°K, were employed. The wire was located on the axis of the collector, which consisted of a 150° sector of a circular cylinder, and was surrounded by two grids for suppression of secondary electron emission. The collector was provided with two slits to admit atomic beams and a third to permit a small fraction of the ion current to enter a mass spectrometer. The pressure was maintained at 10^{-7} mm Hg. The temperature of the central portion of the wire was measured with an optical micropyrometer, and the brightness temperature was reduced to the true temperature using previous data. Measurements of the electronic Schottky effect indicated that an electric field of 5000 v/cm is adequate to compensate the contact fields on the surface of the wire. The value obtained for the thermionic work function (corrected for the Schottky effect) was 4.93 ± 0.04 v. This represents an average of the work functions of the different crystallographic faces of Re crystals that is heavily weighted in favor of the small values and thus close to the minimum work function of Re. This value is compared with previous results. The work function values obtained from the temperature dependence of surface ionization were 5.38 ± 0.03 v for In and 5.46 ± 0.02 v for Ca. The ion currents from the surface ionization of Ag and Mg could be measured only in the mass spectrometer because these metals could not be obtained sufficiently free from alkali metal impurities. The work functions obtained for these metals are, accordingly, not as accurate as the others, but they are in reasonable agreement with the value obtained for Ca. It is concluded that the maximum work function of any crystal surface of Re is greater than 5.40-5.45 v, the work function measured with the elements Ca, Ag, and Mg having high ionization potentials, and that it is less than 5.80 v. (ATD)

REACTOR TECHNOLOGY

General

Refer also to abstract 26514.

27734 (GAMD-6276) PRECON—A FORTRAN PROGRAM FOR COMPUTING CONTAINMENT PRESSURE. R. H. Hansen (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). Mar. 31, 1965. Contract AT(04-3)-167. 53p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

PRECON, a FORTRAN IV program for the IBM 7044 computer, determines the containment pressure in a high-temperature gas-cooled reactor system as a function of time after rupture in the primary system or steam generator. The maximum containment pressure calculated in this way can be used to establish the containment vessel design pressure. The calculation procedure and a sample problem are described. (D.L.C.)

27735 (NAA-SR-10850) AEC UNCLASSIFIED PROGRAMS. Quarterly Technical Progress Report, October–December 1964. (Atomics International, Canoga Park, Calif.). Feb. 15, 1965. Contract AT(11-1)-Gen-8. 268p.

For preceding report see NAA-SR-10501.

Completion of nuclear analyses and thermal and hydraulic studies in the SRE Project are reported along with design of moderator and reflector cells, standard fuel elements, shim and safety rods, core level indicators, and moderator coolant temperature probes. Progress on the design of large sodium-graphite reactors and fuel elements is summarized. Tests associated with these reactors were conducted on corrosion of 316 stainless steel by Na, process tube buckling, and pressure creep rates of 304 stainless steel. Fast reactor design studies were directed toward parameters of Na-cooled coupled reactors (SCCR). It was found that in melt down accidents the effects of prompt neutron lifetimes are of negligible importance in the presence of strong Doppler coefficients. Data from Na heat-transfer studies are being reduced and incorporated in the TRANSFUGUE program. In the SRE expansion program, efforts were devoted to components development for Na cooling systems, including sodium fire hazard analyses and methods for Na-cooled reactor calculations. Feasibility studies on SCCR are summarized. Development of a test facility for Na-cooled reactor components is described. Progress on fabrication of supercritical modular steam generators is reported. Development of SAP-clad UO_2 fuels for the Piqua Power Reactor is reviewed, and results of surveillance of U–Mo and UC fuel element performance in the Hallam Reactor are reported. Processing of irradiated UO_2 with burnups as high as 31,000 Mwd resulting in fabrication of UO_2 pellets is described. Progress is also reported on measurement of Doppler coefficients, properties of BeO, age and diffusion of neutrons, and fission product retention by reactor coolants. Research on reactor accidents, fission effects in metal fuels, high-temperature chemistry, properties of hydrides, radiation chemistry, structure of metals, and radiation damage in solids is summarized. (J.R.D.)

27736 RESEARCH CENTRES IN EUROPE. NO. 4—ISPRA. Euro Nucl., 2: 189-96(Apr. 1965).

The activities, facilities, and organization of the Ispra research center are summarized, with emphasis on the activities and facilities associated with the ORGEL project. (D.C.W.)

27737 A BURST DUCT EXCHANGE PROCESS: AN EXPERIMENTAL STUDY USING A TWO-DIMENSIONAL WATER MODEL. N. G. Calvert, Jill M. Redshaw, and D. Higginbottom (Univ. of Liverpool). J. Brit. Nucl. Energy Soc., 4: 135-6(Apr. 1965).

The burst postulated was a fracture, normal to the axis of one of the lower gas ducts in a hypothetical two-dimensional gas cooled reactor. Studies were made to determine whether there would be an exchange of fluid between the broken duct and atmosphere and the elapse of time between the possible occurrence of a contaminant in the circulating gas and its appearance in the atmosphere outside the fractured duct in the event of such an exchange. The results showed that the dominant feature of the flow pattern within the plenum was the point of separation between the two major eddies whose position varied with the Reynolds number of the flow. The flow from the broken duct was a random surging motion. The most frequently occurring interval between minor surges was 10-12 sec on the larger (6 ft wide) of two models tested. Major surges through the duct were observed at quite irregular intervals. (P.C.H.)

27738 NATURAL VIBRATION OF REACTOR INTERNALS. George J. Bohm (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 22: 143-52(1965). (WCAP-5409)

The transfer matrix method is used to determine the eignevalues and eigenfunctions needed to obtain the response of nuclear power reactor internals to dynamic excitations. Transfer matrices and delta matrices are developed for a particular closed-cycle pressurized-water-reactor (PWR) configuration. Two cases are studied, where the internals are rigidly supported near the bottom by the vessel walls and where the vessel elastically supports the internals requiring that the combined structure be analyzed. The analysis takes into consideration structures with different cross sections and masses that are connected in series and/or parallel. Results obtained with a digital computer are shown. The method and the results obtained can be used for a complete reactor dynamical analysis of most PWR internals, since their structures are similar in design. (auth)

27739 THE BALANCED OSCILLATOR EXPERIMENT. L. Caldarola (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 7: 120-7(Mar. 1965).

The "Balanced Oscillator Experiment" is a type of oscillator experiment to measure transfer functions of fast reactors. The technique consists of simultaneously injecting in a reactor sinusoidal signals of reactivity and coolant flow of the same frequency related to each other in such a way that the coolant temperatures remain constant. In addition to the Doppler reactivity coefficient, this method permits measurement of the fuel thermal conductivity and the heat transfer coefficient between fuel and coolant. Numerical examples are included with reference to the Southwest Experimental Fast Oxide Reactor. (auth)

Auxiliaries and Components

Refer also to abstracts 26628 and 26630.

27740 (UJV-1176/64) BERIHRINGSLOSE ZERSTORINGSFREIE MESSING DER METALLENEN NICHTMAGNETISCHEN TEILE DES REAKTORS. (On Non-Destructive Testing of Non-Magnetic Metallic Reactor Components). F. Vozenílek and P. Kovár (Ustav Jaderného Výzkumu, Ceskoslovenská Akademie Ved, Rez (Czechoslovakia)). Nov. 1964. 37p. Dep.(mn).

Recent work on the nondestructive testing of Al tubes, representing reactor fuel element cladding, capsules used for in-reactor testing, and various stainless steel reactor components is summarized. The method based on eddy-current measurements was found to be very sensitive while yielding stable and reliable values. The location of deliberate cuts into the Al tube wall could be established very rapidly. Examination of 700 fuel elements for the new core of the VVRS reactor revealed that 20 of the elements exhibited deviations from the established standards. The

method was useful for discovering unevenness of the wall thickness of tubes made of nonmagnetic metals. When spent fuel elements are examined, the required radiation-protection methods must be strictly followed. The method could also be used to discover radiation-induced structural changes in the metal; it is considered suitable for large-scale routine testing for indicating if the preset standards are exceeded. Similar tests were also made to determine the corrosion effects on the internal surfaces of pipes and joints made of austenitic steel and used in the coolant circuit of the reactor. (TTT)

27741 SPECIAL VALVES FOR GAS-COOLED, HIGH-TEMPERATURE REACTORS. F. Helfrich, J. Schoening and W. Stuermer (Brown Boveri/Krupp Reaktorbau, GmbH., Mannheim, Ger.). Atomwirtschaft, 10: 172-7(Apr. 1965). (In German).

The circulatory systems of nuclear reactors need shut-off devices, which are sited inside the system or at its entrance and exit points. They serve to stop the circulation of material either for reasons connected with the technique of the process, for safety, or to enable repairs to be undertaken. Reactor valves must chiefly satisfy the following requirements: extreme, quantitatively specified tightness; high functional efficiency (necessary because parts in the active region are accessible and replaceable only with difficulty); and high functional safety (to satisfy the demands of safety shut downs). The valves must be unaffected by radiation. Construction work and experiments are described on the basis of the experience gained in the planning, acceptance, and functional tests, as well as assembly, of the BCC/Krupp high-temperature reactor at Jülich. Problems connected with the internal and external tightness of the valves, operating mechanisms, and indications of the valve status are discussed. Valve types developed are described. (auth)

27742 CHARGING AND DISCHARGING MACHINE FOR THE JRR-3 FUEL ELEMENTS. Fumihiko Itsumi and Kiyoshi Miyazawa (Hitachi, Ltd., Tokyo). Hitachi Hyoron, 46: No. 8, 25-30(Aug. 1964). (In Japanese)

A charging and discharging machine for fuel elements was designed and constructed for JRR-3. A machine is operated on the reactor. The center of the opening of the cask, a part of the machine, is adjusted to the position of the fuel element. The fuel element is lifted and put in the cask. Then the cask is replaced by the container carrying a new fuel element, which is charged into the reactor core to complete the operation. The specifications for the machine as well as the design details for the automatic settling and rail-clamp mechanisms are described. Very rapid (30-sec) automatic settling of this heavy machine (70 tons) to the exact position can be performed with an accuracy of 0.5 mm, and the automatic.gas-tight connection between the machine and the reactor core by the rail-clamp mechanism ensures radiation safety. (NSA of Japan)

27743 THE DESIGN OF A NONLINEAR REACTOR CONTROL SYSTEM. P. Giordano, A. Mathis, and G. Scandellari (C.S.N., Casaccia, Italy). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-12: No. 2, 2-10 (Apr. 1965).

The design procedure for a nonlinear reactor control system is described. The control system contains two nonlinearities, separated by a linear section: a dead-band, normally used to reduce the noise excitation of the control system, and a gear backlash, which in this case is particularly important, due to the fact that the control elements are cylinders with limited effective angular range. The type of electrical motors was also defined (Slo-Syn motors, which can operate as synchronous or stepping motors). Analog and analytical methods were used in parallel, and the final control scheme (a velocity servo with stepping motors) was thoroughly tested on the analog computer with noisy inputs and was theoretically studied with a describing function method extended to the case of systems with multiple nonlinearities connected by linear sections. (auth)

27744 ASPECTS OF DESIGN AND FABRICATION OF IN-PILE LOOPS. FISSION GAS DIFFUSION EXPERIMENT AND VT-1 NEUTRON IRRADIATION EXPERIMENT. Ishikawajima-Harima Giho, 5: No. 21, 20-6(Jan. 1965). (In Japanese)

Outlines of two irradiation experiments built recently are described. Perfect safety, compactness, remote handling, shielding, material, and leak tightness are especially considered because the experiments are to be installed in the reactor core. Design, fabrication, and installation of Fission Gas Diffusion Experiment and VT-1 Neutron Irradiation Experiment were performed by solving these problems step by step after investigations, discussions, and trial productions. (auth)

27745 NEUTRON FLUX IN THE SHIELD OF THE DOUNREAY FAST REACTOR. J. Adamson, A. M. Judd, and N. I. McNair (Dounreay Experimental Reactor Establishment, Caithness, Scot.). J. Brit. Nucl. Energy Soc., 4: 119-34(Apr. 1965).

Neutron-induced reaction rates were measured through the fast reactor shield with the object of testing the validity of using standard bulk shielding calculation methods on DFR. It was found that the measurements did not provide an adequate test because streaming through holes in the shield vitiates its bulk shielding properties. However, on combining the calculations of bulk attenuation and streaming, and making allowance for the difficulty of applying the calculation methods to the complicated geometry of the system, the agreement with the measurements is acceptable. (auth)

27746 A SYSTEM FOR REMOTELY POSITIONING A MOVABLE MEMBER. Michel Aubert, Guillaume Fortin, Rene Gugenberger, Pierre Rouge, and Roger Martin (to Commissariat a l'Energie Atomique). British Patent 984,507. Feb. 24, 1965. Priority date Sept. 26, 1962, France.

A system for remotely positioning a movable member over a path of motion is used chiefly for remote control of fuelling apparatus in a nuclear reactor. The system includes a motor for moving the member over a path and fixed markings spaced along the path. An optical system scans the markings during movement of the member, transmits images to a remote location, and converts the images into corresponding signals. A memory device for storing signals corresponding to selected markings and a comparator for comparing the signals converted from the images with the signals set in the memory are provided. The output from the comparator stops the motor at positions corresponding to the stored signals. (A.G.W.)

27747 IMPROVEMENTS IN OR RELATING TO THE DETECTION OF FISSION PRODUCTS. Murray Vincent Wilson (to Plessey Co. Ltd.). British Patent 984,566. Feb. 24, 1965. Filed Sept. 15, 1960.

A system is patented for detection of delayed-neutron-emitting fission products in the liquid coolant stream of a reactor of the type in which the reactor vessel and primary coolant circuit are enclosed in a secondary pressure vessel. A neutron detection arrangement is located on one side of the wall of the secondary containment vessel and a sample vessel for the coolant is located on the other side of the wall. The vessel is separated from the detector by a metal window that permits passage of neutrons. The sample vessel is thermally insulated from the wall, and the neutron detector is hermetically sealed and readily removable from its operational position. (A.G.W.)

27748 IMPROVEMENTS IN DEVICES FOR DETECTING BREAKS IN FUEL ELEMENT JACKETS IN A NUCLEAR REACTOR. Jean Graftieaux and Andre Roguin (to Commissariat a l'Energie Atomique). British Patent 984,641. Mar. 3, 1965. Priority date May 20, 1960, France.

A device for determining the proportion of diffusion products in a gaseous stream is designed particularly for monitoring an independent experimental loop in a reactor.

The gas to be tested is passed between an ion repulsing fixed electrode and a rotary metallic drum that collects radioactive ions on an area of its periphery for a given time. The drum is then rotated to bring this area into proximity to a counter that measures the radioactivity of the ions. A calculator operatively connected with the counter gives the concentration of short-lived fission products, and the total activity of the gaseous stream. (A.G.W.)

Criticality Studies

See also PHYSICS — Criticality Studies.

Refer also to abstracts 27402, 27412, and 27830.

27749 (BNWL-54) PYRE— A MULTIGROUP BURNUP CODE FOR FAST REACTORS. W. W. Little, Jr., and R. W. Hardie (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1965. Contract AT(45-1)-1830. 74p. Dep.(mn); $3.00(cy), 3(mn) CFSTI.

A description is given of a zero dimensional burnup code capable of handling up to 26 energy groups and 40 isotopes (20 burnable isotopes). The running time is approximately 20 seconds for a typical fast reactor burnup calculation. Input information, a FORTRAN IV source deck listing, and a sample problem are given. (auth)

27750 (JINR-P-2076) O STATISTIKE AMPLITUD VSPYSHEK REAKTORA IBR. (On Statistics of the Amplitudes of the Pulses From the Pulsed Fast Reactor). A. Govorkov and B. Kozik (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics and Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 7p. Dep.(mn).

According to the statistical theory of the neutron multiplication process, a distribution of the amplitudes of the pulses from the pulsed factor reactor was obtained. (auth)

27751 (KAPL-M-6198) THE EFFECT OF MESH SIZE OF NUMERICAL CALCULATION OF POWER PEAKING. Gerald P. Calame (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 1964. Contract W-31-109-eng-52. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The error resulting from the replacement of the diffusion equation by a finite difference equation in two region power peaking calculations is examined. The error is tabulated for a range of material compositions and mesh spacings. It is found that the error is small when the ratio of the mesh spacing to the diffusion length is the same in each region. (auth)

27752 (ORNL-TM-1113) INTERPRETATION OF PULSED SOURCE EXPERIMENTS. C. A. Preskitt and E. A. Nephew (Oak Ridge National Lab., Tenn.). Apr. 27, 1965. Contract W-7405-eng-26. 25p. (CONF-650504-10) Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

Pulsed neutron experiments performed during reactor commissioning programs constitute important examples in which nonseparable transients play an important role. Subcritical states studied with partial core loadings are generally highly reflected, for example, and suffer gross flux distortions upon insertion of control rods. Methods for theoretically simulating the response of nonuniform reactors to pulsed sources were developed and applied to a wide range of typical experimental conditions anticipated during the commissioning program of the Experimental Gas-Cooled Reactor. The space-dependent kinetics equations are solved for two to six neutron groups and one to six delayed neutron precursors by a semi-analytical method which is based entirely on the application of matrix techniques. Two classes of experiments were examined, involving respectively the prompt transient and the total transient. In the first class, the common prompt decay experiment and the ($\bar{\beta}/\bar{\Lambda}$) technique were considered, and in the second the source-jerk experiment. Theoretical simulations of these were used to study the effects of higher modes and other factors affecting their interpretation. It was found that space-dependent effects are greatly suppressed in many important cases in experiments performed with 14-Mev source neutrons. Furthermore, for the source-jerk experiment, a relation was derived involving the volume integration of experimental measurements which provides an exact expression for the reactivity including the effects of all modes. (auth)

27753 (PWAC-453) DETERMINATION OF RELATIVE POWER DISTRIBUTIONS IN CANEL CRITICAL ASSEMBLIES USING CATCHER FOIL TECHNIQUES. W. F. Welsh (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Aircraft Nuclear Engine Lab.). Feb. 24, 1965. Contract AT(30-1)-2789. 45p. Dep.; $3.00(cy), 1(mn) CFSTI.

Aluminum catcher foils, wrapped tightly against uncoated enriched uranium metal strips or blocks, are placed at those locations in a dry critical assembly at which the relative fission rate is to be determined. During operation of the assembly, some of the fission fragments from fissions occurring near the surface of the uranium leave that surface and become embedded in the aluminum catcher foils. The number of fission fragments which embed themselves in a catcher foil is directly proportional to the number of fissions near the contiguous surface of the uranium. The fission fragment deposition in a catcher foil is, therefore, directly proportional to the power density at that location. After shutdown, the catcher foils are removed from the assembly and the gamma activity of the fission fragments embedded in each catcher foil is measured against that of a catcher foil located at the core center. A plot of these relative activities as a function of position within the assembly yields the relative power distribution. (auth)

27754 (TRG-Report-754) A METHOD OF LATTICE CALCULATION FOR GAS-COOLED GRAPHITE-MODERATED REACTORS. J. G. Tyror (Reactor Group, United Kingdom Atomic Energy Authority, Sellafield (England)). Mar. 11, 1964, Reprinted 1965. 14p. Dep.; $0.50(BIS), 2s. 6d. (HMSO).

Lattice calculations involve solving for the neutron spectrum and associated reaction rates in an idealized cell of the reactor. The information thus obtained is then condensed into a form suitable for overall reactor calculations. A technique is described for obtaining approximate cell reaction rates. Although based to a large extent on fundamental nuclear data, it is nevertheless sufficiently simple and rapid to be useful in design calculations. The technique has been coded in FORTRAN II in the programme ARGOSY. (auth)

27755 SOME NUMERICAL EXPERIMENTS CONCERNING SPACE-TIME REACTOR KINETICS BEHAVIOR. J. B. Yasinsky and A. F. Henry (Westinghouse Electric Corp., West Mifflin, Penna.). Nucl. Sci. Eng., 22: 171-81(1965). (WAPD-T-1729)

Numerical comparisons were made between exact and approximate solutions to the two-group space-time diffusion equations. Two slab cores were studied, one 240-cm thick and the other 60-cm thick. Prompt critical bursts and limited ramp insertions of reactivity were simulated by imposing perturbations on the fission cross sections throughout the first quarter of the core. Feedback effects were neglected. Results were obtained using the conventional point kinetics equation, the adiabatic approximation and the space-time synthesis method. For one situation, two nodal methods were also examined. Comparisons with the exact space-time solutions suggest that, when the point kinetics equations are expected on qualitative grounds to be a poor approximation, the actual quantitative errors can be extremely large. Of the other approximations tested the space-time synthesis method gave the most accurate results. (auth)

27756 COMPLEMENTARY USE OF PULSED-NEUTRON AND REACTOR-NOISE MEASUREMENTS. S. R. Bierman, K. L. Garlid, and R. W. Albrecht (Battelle Memorial Inst., Richland, Wash.). Nucl. Sci. Eng., 22: 206-14(1965). (HW-SA-3700)

The complementary nature of pulsed-neutron and reactor-noise techniques in the investigation of reactor dynamic parameters is illuminated by considering the response of a reactor to two types of forcing functions. One of these forcing functions is the impulse function employed in pulsed-neutron studies, while the other is derivable from the inherent randomness of the nuclear events taking place in the reactor. Both the prompt-neutron density following a burst of neutrons into a reactor system and the spectral density of the reactor noise can be expressed in terms of the prompt-neutron decay constant, α. This, in turn, is related to the ratio β/l and the reactivity of the system. Either technique can be used to measure α; however, in practice, each is limited according to a "figure of merit" for a given experimental situation. Measurements made on both subcritical and critical assemblies illustrate the complementary feature of these two techniques and their usefulness in verifying each other's experimental results. (auth)

27757 DIVERGENCE OF THE MEAN POWER LEVEL DURING AN OSCILLATION EXPERIMENT. Harold P. Smith, Jr. (Univ. of California, Berkeley). Nucl. Sci. Eng., 22: 253-4(1965).

A formulation of the reactor dynamics equation for sinusoidal reactivity variation which can be solved analytically is presented. It is thereby possible to estimate the rate of divergence of the power level during an oscillation experiment. Similarly it is possible to predict a mean value of the reactivity less than zero which should eliminate the mean-power-level drift. (C.E.S.)

27758 ON FLUX DEPRESSIONS DUE TO ABSORBER RODS. Karl-Heinz Mueller (CCR Euratom, Ispra, Italy). Nukleonik, 7: 127-30(Mar. 1965).

Using the diffusion treatment of neutron migration, an elementary theory is developed to describe the behavior of the flux in simple arrangements of fuel elements and absorber imbedded in an infinite homogeneous medium. Discrete fuel rods combined with a single absorber rod are treated, assuming that all the rods are very slender and that the neutrons are monoenergetic. Two and multi-group calculations for the same geometry are outlined, and discrete absorber rods are considered. (auth)

Design and Feasibility

27759 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Babcock and Wilcox Co.). British Patent 984,193. Feb. 24, 1965. Priority date Apr. 14, 1960, United States.

A heterogeneous moderated nuclear reactor having a high conversion ratio is patented. The core contains a quantity of fissile material between the critical quantity for light-water operation and the critical quantity for the heavy-water operation, and a mixture of light and heavy water is used as moderator. A blanket of fertile material is disposed around the core. The proportion of heavy water to light water in the moderator mixture can be adjusted to control the reactor and to ensure absorption of neutrons in the fertile material. (A.G.W.)

27760 IMPROVEMENTS IN NUCLEAR REACTORS. (to Societe Anglo-Belge Vulcain S. A.). British Patent 984,439. Feb. 24, 1965. Priority date Mar. 9, 1961, Belgium.

A structure for a nuclear reactor is designed to be removed from and returned to the reactor vessel as a unit. The structure includes fuel elements, a support for the fuel elements, a control rod, and an actuating mechanism for the control rod. (A.G.W.)

27761 A NUCLEAR REACTOR FOR USE UNDERGROUND IN BOREHOLES OR SHAFTS. (to Siemens-Schuckertwerke AG). British Patent 984,594. Feb. 24, 1965. Priority date June 9, 1962, Germany.

A nuclear reactor for use underground is designed to be brought to its intended operating position and subsequently expanded to an operating diameter greater than the minimum diameter of the bore through which it passed. Some expansion of the reactor vessel is provided by stretching of the wall materials; more can be provided by a fold or folds in the vessel walls. The expansion is brought about by pumping a liquid such as water into the vessel at high pressure or by triggering a chemical propellant charge within the vessel. (A.G.W.)

27762 HETEROGENEOUS NUCLEAR REACTORS. Henry J. Hibshman (to Esso Research and Engineering Co.). U. S. Patent 3,172,818. Mar. 9, 1965. Filed Sept. 30, 1959.

Improved heat removal from a heterogeneous reactor is obtained by moving solid fuel into and out of a critical mass zone with external cooling of the solid fuel. Fuel elements are designed in the form of rotatable disks or continuous elongated elements such as belts, and are arranged to move continuously through the reaction zone in such a manner that at a given time a minor portion of each element is inside the reaction zone and a major portion is outside the reaction zone. The major portion of each element is cooled while outside the reaction zone; the sum of minor portions is sufficient to maintain a nuclear reaction inside the reaction zone. The fuel elements may be completely separated for control purposes. (A.G.W.)

27763 FLOW RESTRICTOR FOR A FUEL CHANNEL IN A NUCLEAR REACTOR. James S. Picton (to Babcock and Wilcox Ltd.). U. S. Patent 3,172,819. Mar. 9, 1965. Priority date Apr. 1, 1960, Great Britain.

A gas-cooled reactor having upright fuel channels arranged for upward flow of coolant and upward withdrawal of fuel elements is designed for refuelling during operation. Each fuel channel is provided with a movable coolant-flow restrictor normally maintained in an inoperative position by the downward force of at least one fuel element. When the fuel element is lifted, the restrictor is moved into a position in which it limits the rate of coolant flow through the channel. (A.G.W.)

27764 NEUTRONIC REACTOR. Carl Einar A. Lenngren, B. Oscar Aldor Jonsson, Hugo E. Nilsson, Lars G. Zettergren, and Per Erik Schmeling (to Rederiaktiebolaget Nordstjernam). U. S. Patent 3,172,820. Mar. 9, 1965. Priority date July 25, 1958, Sweden.

In a graphite-moderated, gas-cooled, heterogeneous reactor the moderator is divided into two basic parts separated by a cooling means. About 20 to 30% of the moderator is incorporated with the fuel into moderator-fuel rods. The other part of the moderator is formed into columns each of which has an axial passageway in which a moderator-fuel rod is positioned in such a manner as to form an annular passage for flow of cooling fluid. The design is intended to provide good temperature distribution, good neutron economy, and easy refuelling. (A.G.W.)

Fuels

27765 (AECL-2226) WORK METHODS FOR THE POST-IRRADIATION EXAMINATION OF EXPERIMENTAL FUEL ELEMENTS. A. S. Bain, R. D. MacDonald, D. B. Kerr, J. R. Kelm, and R. J. Chenier (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Mar. 1965. 14p. Dep.; $0.50(AECL).

At Chalk River, the personnel engaged on materials research operate two high-density concrete hot cells and a line of seven lead-shielded dry boxes for the examination of irradiated fuel specimens, both metal and ceramic. Transfer techniques and working methods for a typical

examination are described. Experience over the past nine years has shown that having the research personnel directly in charge of the detailed postirradiation examination has several advantages, such as flexibility in scheduling, knowledge of the limits of remote control operation allowing rapid development of suitable equipment, and elimination of misunderstandings and delays in the dissemination of postirradiation results. (auth)

27766 (HW-78968) FLEX 2—A FUEL ELEMENT DESIGN/ANALYSIS CODE. R. J. Shields (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 18, 1963. Contract AT(45-1)-1350. 28p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

FLEX 2 analyzes the steady-state behavior of fuel-element-lattice-cells. The neutron reaction rates are calculated for four energy groups by the P_3 approximation. Standard thermal-hydraulic models are used for fuel element temperatures, flow rates, pressure drops, etc. FLEX 2 is limited to concentric-cylinder lattices that also fulfill further requirements. (T.F.H.)

27767 (ORNL-TM-1133) NUCLEAR FUEL CYCLE RESEARCH IN RUSSIA: A LITERATURE SURVEY. A. T. Gresky (Oak Ridge National Lab., Tenn.). May 13, 1965. Contract W-7405-eng-26. 512p. Dep.(mn); $8.12(cy), 8(mn) CFSTI.

A rather general literature survey of Soviet nuclear fuel cycle research is presented, along with compilations of contributing scientists, their institutes, several thousand of their publications or articles which have appeared in the open literature, and several representative abstracts of these articles. The publication period covered is mostly the interval between 1955 and mid-1963; however, a few papers extending back to the early 1940's are listed because of their historical interest. Though primary attention is given to the chemical or chemical engineering aspects of the fuel cycle, a considerable number of the selected articles deal with related aspects of metallurgy and solid state physics, as well as reactor physics, high energy physics, health physics, biology and medicine, isotope separations, radioisotope utilization, and so forth. (auth)

27768 (SCNC-308) SEVENTEENTH QUARTERLY PROGRESS REPORT ON ANP DEVELOPMENT FOR PERIOD ENDING MARCH 31, 1960. (Sylvania-Corning Nuclear Corp., Bayside, N. Y.). May 1960. Contract AT(30-1)-366. 61p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Work during the period was devoted to coating alloys of improved strength as compared with the Nb-40 at. % Ti alloy formerly used as a standard, by modification of the coating baths. Effort was also continued on advanced burner rig testing of fuel element prototypes clad with the Nb-40 at. % Ti alloy. Laboratory tests were made to obtain information relating to the burner rig tests. (J.R.D.)

27769 (CEA-tr-A-1641) PROBLEMES DE MATERIAUX LORS DE L'UTILISATION DU PLUTONIUM COMME COMBUSTIBLE DANS LES REACTEURS. (Materials Problems in the Use of Plutonium as a Reactor Fuel). U. Benedict. Translated into French by M. Bioche (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay), from a EURATOM report. Aug. 4, 1964. 33p. Dep.(mn); $3.60(fs), $1.19(mf) JCL.

A review is given of the different fuel elements containing Pu, now being used or being considered for use in reactors. Some significant properties for the reactor utilization of the Pu compounds discussed are summarized. The alloys and other systems containing Pu are tabulated and their properties are compared. The most important materials problems in the fabrication and putting in service of the different fuels are discussed. Reactors already in operation or planned that use Pu fuel elements are tabulated. (tr-auth)

27770 IMPROVEMENTS IN OR RELATING TO FINNED TUBULAR BODIES. Alan Charles Anthony Saunders and Ronald Scott Challender (to United Kingdom Atomic Energy Authority). British Patent 984,931. Mar. 3, 1965. Filed Dec. 28, 1960.

A finned tubular body suitable as a sheath for nuclear fuel has heat transfer fins integral with the body and disposed in an even number of sectors around the body. The fins in adjacent sectors are inclined to one another and to the longitudinal axis of the body to form a herringbone pattern. Longitudinal strengthening ribs may be provided. The fins are formed of parallel plates either flat or curved in one direction only. (A.G.W.)

27771 FUEL ELEMENTS. Gilbert Wayne Meyers (to Babcock and Wilcox Co.). U. S. Patent 3,172,821. Mar. 9, 1965. Filed Apr. 30, 1959.

An arrangement for spacing a bundle of fuel pins within a fuel element is intended to secure the pins against misalignment or movement that would interfere with the flow of coolant. The internal fuel components are spaced from one another by short tubular internal ferrules integrally attached to the fuel components to provide a unitary bundle. A number of short tubular peripheral ferrules are positioned between and integrally attached to the peripheral fuel components and extend beyond the perimeter of the bundle to provide bumpers, which protect the fuel pins from contact with adjacent surfaces. (A.G.W.)

Power and Power-Breeder Reactors

Refer also to abstract 27752.

27772 (ACNP-64010) SUPERHEATER THERMAL SHOCK TESTS. Ralph H. Klumb (Allis-Chalmers Mfg. Co., Milwaukee, Wis. Atomic Energy Div.). Feb. 4, 1965. For Northern States Power Co., Minneapolis, Minn. and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. 83p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The Pathfinder superheater core is flooded with saturated water after shutdown, thus inducing thermal shock in the superheater fuel elements. A superheater fuel element, containing a stainless steel-clad uranium dioxide-stainless steel cermet fuel tube, was subjected to conditions duplicating the reactor flooding. Dimensional analyses and inspections for cracks and distortion were made. Dimensional changes and distortion occurred in the elements, but there were no cracks. It was observed that the fuel tubes became blanketed with steam, which greatly reduced the severity of the quench, and that low flow rates and subcooling of the coolant increased the severity. A method was developed to predict the number of thermal shock cycles that an element can withstand for a given degree of thermal shock. (W.L.G.)

27773 (ANL-6939) SELECTION OF THE STRUCTURAL MATERIAL FOR THE FARET LIQUID-METAL SYSTEMS. L. R. Kelman and R. J. Dunworth (Argonne National Lab., Ill.). Dec. 1964. Contract W-31-109-eng-38. 25p. Dep.; $2.00(cy), 1(mn) CFSTI.

The properties of austenitic stainless steels and the relatively new superalloys were compared against the extrapolated requirements for the core structure, primary vessel, and piping of FARET. It was concluded that type 304 stainless steel comes closest, with type 316 second, to meeting FARET conditions and material selection requirements. (W.L.G.)

27774 (BNWL-40) PRTR FUEL ELEMENT RUPTURE TEST FACILITY CAPABILITIES AND PROJECT HISTORY. P. C. Walkup (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1, 1965. Contract AT(45-1)-1830. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A description is given of the fuel element rupture test facility (rupture loop in PRTR). Information is given on its capabilities and limitations. The history of the construction of the facility is also included. (D.L.C.)

27775 (CEA-R-2570) L'ELEMENT COMBUSTIBLE DU 1e JEU DE EL 4, PRESENTATION, PROBLEMES ESSENTIELS POSES PAR L'ETUDE PROBLEMES DE

FABRICATION. (The Fuel Element of the First Charge for EL 4: Presentation of Main Problems Arising in the Research and Production Problems). Claude Ringot, Henri Bailly, Roko Bujas, and Henri Vidal (Commissariat à l'Énergie Atomique, Saclay (France), Centre d'Études Nucléaires). Aug. 1964. 44p. Dep.(mn).

The fuel element making up the first charge for EL 4 is made of slightly enriched uranium oxide canned in stainless steel. This fuel element makes it possible to operate the reactor in the safest conditions awaiting the development of the fuel which will be finally adopted; this will have a low absorption can: beryllium or a zirconium copper alloy. The 500-mm assembly is made up of 19 small rods placed on 3 rings, inside a graphite jacket. The solution adopted was with completely independent small rods. Possible problems resulting from study and production of the fuel elements are considered. (auth)

27776 (CVNA-230) MONTHLY OPERATING REPORT, FEBRUARY 1965. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). Contract AT(30-1)-2289. 31p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Reactor operation continued at essentially full licensed power during February. Two scrams occurred. One was caused by a malfunction in the automatic control rod system, and the other by an operator who inadvertently tripped a primary coolant pump. The generator was on the line for 643.11 hours during the month of February, and the gross electrical generation was 6,577,000 kwh. The reactor availability factor was 97.82%. Routine and special instrument/electrical and mechanical maintenance, chemistry, and health physics work was performed in support of plant operation and preparations were made for shutdown. Heavy and light water systems chemistry generally remained within specifications. The reactor was scrammed intentionally for test purposes and another scram occurred as a result of the test work. After the test work was completed, the reactor was shut down for maintenance. (auth)

27777 (DLCS-5680301) REACTOR PLANT CONTAINER INTEGRITY TESTS. (BUTTERFLY VALVE HYDRAULIC SYSTEM TEST). Test Evaluation. (Duquesne Light Co., Shippingport, Pa.). First issue, Mar. 2, 1965. Contract AT(11-1)-292. 16p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An attempt was made to determine butterfly valve closure times under conditions of low accumulator nitrogen pressure and low accumulator hydraulic pressure. The results of this test indicate that the butterfly valves close within 3.4 seconds of the time that a trip signal is applied from the Operational Radiation Monitoring System (ORMS). The data indicated that valve closure times might be reduced by replacing the emergency solenoid valves with valves of larger capacity in conjunction with modification to the electrical control circuitry. (auth)

27778 (GA-4124) EXPERIMENTAL BERYLLIUM OXIDE REACTOR PROGRAM. Quarterly Progress Report for the Period Ending, March 31, 1963. (General Atomic, San Diego, Calif.). Apr. 26, 1963. Contract AT(04-3)-187. 42p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Progress is reported in engineering, physics, and materials studies in the program to develop a 10-megawatt, gas-cooled, BeO-moderated reactor. (W.L.G.)

27779 (HPR-52) DYNAMIC TEST LOOP EXPERIMENTS INVESTIGATING DOWNCOMER VOID. R. Grumbach, A. Hoeld, and H. H. Vollmer (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Dec. 1964. 51p. Dep.(mn).

Dynamic experiments were carried out in a boiling test loop in order to study downcomer void phenomena. Such experimental conditions were chosen that the results are relevant to HBWR second charge with respect to channel power and pressure. The test loop geometry corresponds to the dimensions of a unit cell in the HBWR. Perturbations in loop pressure, caused by changes in subcooling or heating power, were introduced and the responses in temperature and pressure along the downcomer were observed at several positions. The experimental data were utilized to calculate the average steam velocity in water as function of void fraction, and the average void fraction as function of pressure and pressure gradient. In order to get reasonable experimental accuracy, the magnitude of the moderator void fraction in the test loop had to be in a range up to 15%, whereas the moderator void in the reactor is in the order of some 0.1%. This fact necessitated a mathematical description of the temperature and void behavior including nonlinear effects which are negligible at small perturbations. (auth)

27780 (LA-3279) ULTRA HIGH TEMPERATURE REACTOR CRITICAL EXPERIMENT (UCX) SAFETY ANALYSIS REPORT. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Mar. 1965. Contract W-7405-eng-36. 97p. Dep.; $4.00(cy), 2(mn) CFSTI.

The UHTREX Critical Experiment uses the core, reflector, fuel elements, and control rod materials of UHTREX to produce data for the verification of nuclear design calculations. Components of the critical assembly and the plans for its operation are described and discussed, as are the location and design features of the test facility. Hazards that might arise during UCX operation are described and the consequences analyzed. Consequences of conceivable excursions are minor, with effects limited to the assembly test cell. (auth)

27781 (NMI-7263) POWER REACTOR PROGRAM. DEVELOPMENT OF FABRICATION PROCESS FOR DRIVER TUBES FOR THE HWCTR. J. Siergiej, D. M. Davies, and W. J. Richmond (Nuclear Metals, West Concord, Mass.). Nov. 30, 1864. Contract AT(30-1)-2784. 66p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A description of the fabrication procedures and equipment for driver tubes for HWCTR is given. A reaction which occurred between the copper cans and the Zircaloy cladding during extrusion was eliminated by allowing a nitride film to develop on the Zircaloy surfaces during billet heating. The film and copper can are subsequently removed resulting in an acceptable surface finish and corrosion quality of the Zircaloy cladding. (W.L.G.)

27782 (ORNL-TM-1127) DESCRIPTION OF FACILITY RADIATION AND CONTAMINATION SYSTEMS INSTALLED IN THE MOLTEN-SALT REACTOR EXPERIMENT BLDG. 7503. J. A. Russell, Jr. and D. J. Knowles (Oak Ridge National Lab., Tenn.). May 13, 1965. Contract W-7405-eng-26. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Facility Radiation and Contamination Systems were installed in the Molten-Salt Reactor Experiment Building 7503 to continuously and automatically monitor gamma radiation (by seven gamma monitrons) and air contamination (by seven beta-gamma air monitors) in the entire facility. These instruments and other components in the network provide health physics monitoring information, sound local alarms when abnormal conditions occur, and indicate the abnormal conditions on a central panel board. Operating personnel are first given warning when a "caution level" of 7.5 mR/hr or 1000 counts/min is detected by a monitron or beta-gamma air monitor, respectively. A second warning is given when a "high level" is detected, i.e., 23 mR/hr by a monitron or 4000 counts/min by a beta-gamma air monitor. The building evacuation system operates automatically when two or more monitrons or two or more air monitors detect a "high level" of radiation or air contamination. (auth)

27783 (SRO-113) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, FEBRUARY 1965. (Savannah River Operations Office, Atomic Energy Commission, Aiken, S. C.). 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The scope of a developmental program for heavy water-cooled organic reactors in the size range 1,000 to 10,000 Mw(t) for water desalination is described, and the status of the various sub-programs is reported. Work on the thorium fuel cycle is also described along with the AEC-

AECL cooperative program and the power demonstration program. (J.R.D.)

27784 (UNC-5095) FUEL CLAD SELECTION FOR CONNECTICUT YANKEE, CORE I. R. Holden, L. Joseph, M. LaBar, and J. McKee (United Nuclear Corp., White Plains, N. Y. Development Div.). Aug. 31, 1964. Contract AT(30-1)-3250. 60p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A comparative evaluation was carried out on Zircaloy and cold-worked stainless steel cladding for use in the first core loading of the Connecticut Yankee reactor. The evaluation included a review of in-pile and out-of-pile data, and of Zircaloy fabrication experience. Because of the relative lack of experience with Zircaloy, it is recommended that cold-worked type 304 stainless steel be used to assure attainment of the desired fuel burnup. (D.L.C.)

27785 THE LINGEN NUCLEAR POWER STATION. O. Deublein (Kernkraftwerk Lingen, GmbH, Dortmund, Ger.). Atomwirtschaft, 10: 162-9(Apr. 1965). (In German)

Construction progress of the Lingen nuclear power station near Darme is reported. The station was designed to have a net electrical capacity of 240 Mw produced by a single-circuit boiling-water reactor of 514 Mw(t) loading and an after-connected oil-fired superheater. The turbine set was designed for 252 Mw(e). An increase of capacity to 270 Mw and, after reconstruction, to 295 Mw is possible. The steam temperature is raised from 260 to 535°C in the superheater so that a conventional turbine can be used. The reactor supplies 980 ton/hr of primary steam at 72 atm and 878 ton/hr of secondary steam at 49 atm pressure is produced in two heat exchangers. The steam pressure at the front end of the turbine is 42 atm and its temperature 530°C. The superheater is designed for a maximum hot steam quantity of 950 ton/hr. The turbine is in two housings, the high-pressure part with nine expansion stages and the low-pressure part with four. Two condensers, each with 9,200 m^2 of cooling surface, are arranged perpendicular to the turbine axis. The electrical power generated is fed into the 220 kv grid of the Vereinigte Elektrizitätswerke Westfalen AG (VEW). The reactor core consists of 316 fuel elements each with 36 rods, which are packaged into a square case of Zircaloy. UO_2 at 2.4% enrichment is used as fuel in the form of sintered tablets in Zircaloy-2 cladding. One charge consists of 34 tons of uranium. The reactor is regulated by 69 cruciform control rods consisting of steel tubes filled with boron carbide, which are introduced into the core from the underside. Rapid shutdown (scram) is accomplished hydraulically. In the case of a new core, poison sheets between the fuel elements offset the excess reactivity. The total installation costs of the nuclear power station inclusive of the first core amount to DM 270 million. Power generating costs at 5,000 operating hours per year are considered to be competitive with a hard coal station of similar output if account is taken of considered financial and tax privileges. (auth)

27786 COSTS OF REACTOR CONTAINMENTS FOR POWER REACTORS. W. Ullrich (Allegemeine Elektrizitatsgesellschaft Frankfurt am Main). Atomwirtschaft, 10: 169-71(Apr. 1965).

Reactor containment, which, for safety, must be constructed as a pressure shell, is a significant cost factor in an atomic power station. A cost comparison is made of those forms of containment for light-water reactors. These are the standard containment and the pressure suppression systems. Of 27 light-water reactors built or under construction 19 have standard containment and 4 pressure suppression systems while one each was built with a composite pressure shell or in a cave. Two further power reactors, in the USSR, possess no pressure-tight reactor containments. In planning and in determining the costs of a reactor pressure shell the following aspects are considered especially important: dimensions, shape of the containment, material and basis used for calculating the costs. The dimensions and the design pressure are determined the light of the reactor power and the thermal content of the primary system. In addition to the space needs for auxiliary equipment the maximum permissible wall thickness, which, in the case of steel pressure shells, can be welded without annealing, is decisive in determining how small the containment can be. The sphere is basically the most suitable shape, but, particularly for a specified height of reactor, the cylinder makes possible the most compact construction. The dimensions of the reactor and the primary circulation system play a decisive role in determining the size and design pressure of the containment; the reactor power scarcely influences the pressure. This system is particularly suitable for boiling-water reactors with a direct circulation system. A reduction of costs and building time is expected from the use of reinforced concrete for pressure shells. (auth)

27787 THE STATUS OF AUTOMATION IN NUCLEAR POWER STATIONS. W. Basti (Institut fur Mess- und Regelungstechnik, Munich). Atomwirtschaft, 10: 189-92 (Apr. 1965). (In German)

In the field of nuclear power station technology only partial automation was achieved. The most important application areas are data processing, calculation of various parameters of the installation, monitoring control circuits, carrying out of corrective measures, sequential control operations, and optimization. The technique of central automation is used in those automated nuclear power stations, which are in operation. Digital computers are used as the central data processing equipment. The nuclear power stations are partially automated, the emphasis being on data processing. Comprehensive concepts for full automation exist for a few installations. The Big Rock Point, CANDU, EDF-1, EDF-2, and SELNI are considered examples of automated nuclear power stations. EDF-3, EDF-4, and EDF-5 are being prepared for comprehensive automation. Although so far the most important task of the digital computer involve the data processing of nuclear power stations, optimisation of the installation is the main aim of the future. Information sources for the computer must be carefully selected in order to minimize the number of measurement points needed. (auth)

27788 PROVISIONAL EVALUATION OF THE HINKLEY POINT NUCLEAR ENERGY CENTER. D. C. Eastwood. Atoomenergie Haar Toepassingen, 7: 28-33(Feb. 1965). (In Dutch)

The design of the Hinkley Point nuclear power plant, which reached power in December 1964, formed an important step in the British construction program for nuclear power reactors. The technical requirements made since the construction of the experimental power plant at Calder Hall are described. The speed of development is shown by the fact that design changes were made even after construction had already begun. (tr-auth)

27789 APPLICATIONS OF OXIDE-DISPERSION-STRENGTHENED ALUMINUM ALLOYS IN ORGANIC-COOLED POWER REACTORS. D. G. Boxall and D. J. C. Fleming (Canadian General Electric Co. Ltd., Peterborough, Ont.). Can. Mining Met. Bull., 58: 407-12 (Apr. 1965).

As an alternative to heavy-water cooling, reactors cooled by organic liquids are being developed in Canada. One of the areas in which development was required is that of core materials. The factors affecting the selection of fuel canning and coolant tube materials are discussed. It is shown that SAP is a potentially attractive material for these applications. The fabrication of fuel sheathing is discussed. Difficulties due to large inclusions and blistering due to high hydrogen contents were overcome by magnetic separation and vacuum sintering of the powders. High-quality tubes can be produced by extrusion to finished size. A study was made of the mechanical properties of fuel-sheathing tubes and bar stock. The stress rupture properties of the tubes subjected to uniaxial and biaxial stress were determined. The biaxial stress tests were performed by internal pressurization. For times in excess of about 200 hours, the curve of stress against time to rupture was extremely flat. The secondary creep rates of SAP were very low and there was

no appreciable tertiary creep stage. The effects of strain rate, notches, and cold work on the mechanical properties were investigated and the results are reported. Decreasing the strain rate decreased the ductility and increased the notch sensitivity. It was concluded that SAP can be used successfully as a reactor core constructional material provided that the design takes into account its limited ability to accommodate plastic strain. (auth)

27790 DEGREE OF IRRADIATION OF THE FUEL OF THE ZORITA NUCLEAR POWER PLANT. Emilio Fustel (Ingeniero Industrial, Tecnatom, South America). Energia Nucl. (Madrid), 8: No. 32, 42-51(Oct.-Dec. 1964). (In Spanish)

The burnup attainable in the PWR-type reactor planned for the Zorita nuclear power plant was calculated. The results proved the possibility of obtaining 24,000 Mwd/t for the fuel for initial and final enrichments of 3.15 and 1.30%, respectively. (J.S.R.)

27791 THE EXPERIENCE GAINED IN DESIGNING THE NUCLEAR SECTION OF THE SELNI POWER PLANT. CONSIDERATIONS OF THE DEVELOPMENT TRENDS OF PWR REACTORS. R. Casini (Societa Elettronucleare Italiana, Milan). Energia Nucl. (Milan), 12: 245-53(May 1965). (In Italian)

Several technological developments are illustrated, which made it possible to increase the heat output of the first reactor core of the Enrico Fermi Plant at Trino Vercellese from the original guaranteed level of 615 Mw(t) to the present design rating of 825 Mw(t). The advantages of using chemical shim are especially discussed. On the basis of the design and operating experience accrued with the Enrico Fermi Project, important developments in the field of pressurized water reactors to be expected in the near future are discussed. (auth)

27792 PRESSURE RESISTANCE AND LEAKAGE TESTS PERFORMED ON THE PRESSURE VESSEL OF THE TOKAI POWER STATION REACTOR. Osamu Hotta (Fuji Electric Mfg. Co., Ltd., Japan). FAPIG (Tokyo), No. 32, 96-9(June 1964). (In Japanese)

The pressure and air-leak tests were carried out according to Lloyd's provisional specifications. An air pressure of 25.0 kg cm^2 was used for the pressure test. The pressure was increased in the vessel in stages of 4.0, 7.0, 12.0, 16.2, 20.3, 22.5, and 25.0 kg/cm^2. The temperature of the vessel was maintained in the range of 20–30°C for the parts constructed of 92-mm-thick plates and of 15–30°C for the parts constructed of 80-mm-thick plates. In the production of the high-pressure air required in the test, the air source in the Station was used, the pressure being increased by means of compressors from 6 kg cm^2 to 28 kg/cm^2. The temperature of the air was controlled by electric heaters; the heated air was injected into the vessel at a horizontal position and circulated for maintaining the temperature distribution uniform in the vessel. The temperature was measured at 29 points and recorded on automatic recorders. Soap water (20%) was used in the leak test performed. (NSA of Japan)

27793 PLANNING OF THE DOMESTIC PRODUCTION OF THE FUEL-ROD CLADDING TUBES FOR USE IN THE JPDR, AND THE PRELIMINARY INVESTIGATIONS. Nobuo Kunimoto (Kobe Steel Works, Ltd., Japan). FAPIG (Tokyo), No. 32, 100-5(June 1964). (In Japanese)

Tests were made on Zircaloy-2 tubes made in Japan and in other countries. The results of these tests were checked against the ASTM and the specifications of the JAERI. The tests made were as follows: chemical analysis, dimensional measurements, tensile test, hardness test, flow test, surface roughness test, corrosion test, autoclave test, and metallographic examination. The production of Zircaloy-2 tubes (or pipes) in the U.S.A. is so large that the total amount of tubes produced by 1961 reached 4000 tons. (NSA of Japan)

27794 MANUFACTURE OF PRESSURE VESSEL FOR NUCLEAR POWER REACTOR AT TOKAI ATOMIC POWER STATION. Kazukiyo Okano (Fuji Electric Mfg. Co., Ltd., Japan). Fuji Jiho, 38: 174-9(Feb. 1965). (In Japanese)

A nuclear power station, the first commercial station in our country now being constructed in Tokai-Mura, is expected to start its normal operation in April 1965. Problems involved in the fabrication of the huge pressure vessel, diameter of about 20 m, are discussed. (auth)

27795 EXPERIMENTAL STUDIES OF STEAM–WATER SEPARATOR FOR BOILING WATER REACTORS. REPORT No. 1. Ishikawajima-Harima Giho, 5: No. 21, 11-19(Jan. 1965). (In Japanese)

The object of these experimental studies is to develop a compact and more efficient steam–water separator to be installed in the pressure vessel of a large forced circulation boiling water reactor. The steam–water separator has various axial flow type vanes and separation is performed by centrifugal force induced by vanes. The tests are done under two pressure ranges: low (0 ~ 4 kg/cm^2 g) and high (65 ~ 70 kg/cm^2 g). Only the results of low-pressure experiments are described. The effects of various parameters on the separating efficiency are studied. The results may be summarized as follows: (1) the effect of centrifugal force on efficiency is not large; (2) 12 vanes are enough; (3) the best vane outlet angle is 60°; (4) the difference of vane type (flat-plate type or forced voltex type) does not affect efficiency much; (5) the use of a secondary separator results in good efficiency, about 90%; (6) an increase of pressure stabilizes the system and results in higher efficiency. (auth)

27796 AGR DEVELOPMENT. J. Moore (Atomic Energy Authority, Windscale Works, Sellafield, Cumb., Eng.). J. Brit. Nucl. Energy Soc., 4: 97-108(Apr. 1965).

The reactor physics, fuel design, fuel irradiation experience, and future plans for AGR development are discussed. (P.C.H.)

27797 OPERATING EXPERIENCE WITH THE WINDSCALE ADVANCED GAS-COOLED REACTOR. A. D. Evans and L. Barton (Atomic Energy Authority, Windscale Works and Calder Works, Sellafield, Cumb., Eng.). J. Brit. Nucl. Energy Soc., 4: 109-18(Apr. 1965).

Experience gained during the first 2 years of power operation of the Windscale AGR is described, with particular reference to plant features relevant to the design of commercial AGR stations. Despite an intensive experimental program increases in plant output have been achieved and high plant availability factors maintained. Developments in safety control features are described which permit prototype commercial AGR fuel to be safely irradiated without invoking the special design features of the containment building while still assuming a more severe maximum credible fault than will apply in future designs with concrete pressure vessels. (auth)

27798 FUEL ELEMENT FOR THE TOKAI POWER STATION REACTOR. Chuichi Asada (Japan Atomic Power Co., Tokyo). Karyoku Hatsuden, 15: 632-7(Aug. 1964). (In Japanese)

The fuel element developed for the Tokai Power Station reactor is a natural uranium hollow rod clad with Magnox and supported in a graphite sleeve. The hollow fuel rod has a very large specific output and therefore saves uranium compared with solid fuel rods used in similar reactors in England. The fuel element has many other advantages from its unique structure. These features as well as the design of the fuel element are described. The thermal conductance and gas dynamics, two important parameters in the design of reactors of this kind, are also described. Of the problems involved in the design of the fuel element, the swelling, creep, and end cap design are specially discussed. (NSA of Japan)

27799 THE SETTLED-BED FAST-REACTOR CONCEPT—1000-MWe REACTOR DESIGN. L. Green, M. M. Levine, A. Aronson, et al. (Brookhaven National Lab., Upton, N. Y.). Nucl. Appl., 1: 107-30(Apr. 1965). (BNL-8625)

An analysis of a conceptual design for a 1000-Mw(e)

settled-bed fast reactor fueled with UC and PuC spheres and cooled by liquid sodium was made to determine its technical and economic feasibility. The study includes a reactor physics analysis, an engineering analysis of the thermal and hydraulic characteristics, and a study of the system economics. The study showed that there are no inherent technical problems for a settled-bed fast reactor of this size. Total power-generating costs were shown to be as low as 3.84 mills/kwh for fuel leased from the AEC and 4.14 mills/kwh for fuel that is privately owned. (auth)

27800 WYLFA NUCLEAR POWER STATION. Nucl. Eng., 10: 141-54(Apr. 1965).

The design and development of the pressure vessel, cooling system, steam cycle and boiler, control and instrumentation, fueling equipment, and fuel elements of the Wylfa Nuclear Power Station are discussed. (C.E.S.)

27801 OPERATING CVTR. W. E. Selkinghaus (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. Carolina). Nucleonics, 23: No. 5, 49; 52-3(May 1965).

The operation and performance of the heavy water-cooled and -moderated, pressure-tube reactor are summarized, including startup difficulties with the heat exchangers, header-cavity contamination, insulation, and control rod drives. Some development work is also covered. (D.C.W.)

27802 EVALUATING COOLANTS FOR FAST-BREEDER REACTORS. Nucleonics, 23: No. 5, 54-62 (May 1965).

A brief survey on fast-breeder coolant concepts is presented, with emphasis on gas- and steam-cooled reactors. Sodium-cooled reactors are also briefly discussed. Coolant properties, costs, and reactor characteristics are considered, together with reactor designs. (D.C.W.)

27803 ADVANCES IN HIGH-POWER DENSITY BWR's. PART II. POWER-FLATTENING TECHNIQUES BOOST BWR CORE CAPABILITIES. N. H. Barth and R. K. Haling (General Electric Co., San Jose, Calif.). Nucleonics, 23: No. 5, 72-3; 76-7(May 1965).

The power-flattening techniques considered in the course of the high-power-density development program at Big Rock Point are discussed, with consideration of power-density performance tests and of the physics analyses performed for all operating configurations at Big Rock Point prior to operation. Operation at 60 kw/l with an overall peaking factor of ~2.2 was achieved. (D.C.W.)

27804 MYSTERY OBJECT JAMS INDIAN POINT CONTROL ROD. Nucleonics, 23: No. 5, 90(May 1965).

On Feb. 5, 1965, an unidentified foreign object caused a control rod in the Indian Point Power Reactor to stick in the withdrawn position. The discovery and removal of the object are summarized, together with some speculations on the manner in which it entered the reactor. (D.C.W.)

27805 ANALIZ TERMODINAMICHESKOGO TSIKLA ATOMNYKH ELEKTROSTANTSII METODOM BAZOVOI TOCHKI. (Analysis of Thermodynamic Cycle of Atomic Power Stations). Yu. D. Arsen'ev. Moscow, Gosatomizdat, 1962. 136p.

An analysis is made of the optimum thermodynamic cycle for nuclear and ordinary power stations. The optimum thermodynamic cycle is determined by a system of equations analogous to the equations of the theory of similarity. The optimum cycle for a nuclear power plant with a water-cooled, water-moderated reactor was calculated. (R.V.J.)

27806 METHOD OF PRODUCING FUEL ELEMENTS FOR POWER REACTORS. (to Beteiligungs- und Patentverwaltungsgesellschaft Mit Beschrankter Haftung). British Patent 984,387. Feb. 24, 1965. Priority date June 23, 1961, Germany.

A cylindrical or spherical fuel element for a nuclear reactor can be produced by applying successive layers of a compressed moderator to a core of fuel. Each layer, after application, is provided with a consolidated surface zone by impregnating it with a hydrocarbon and then heating. (A.G.W.)

27807 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to General Dynamics Corp.). British Patent 984,656. Mar. 3, 1965. Priority date Feb. 18, 1963, United States.

A nuclear reactor having a prompt negative temperature coefficient of reactivity is designed to produce about 10 Mw(t) of power. Tubular fuel elements contain a solid homogeneous mixture of zirconium hydride and fully enriched uranium such that the ratio of hydrogen atoms to zirconium atoms is at least approximately 1.5 to 1. Each fuel element also contains a poison, preferably erbium. A liquid coolant-moderator is used. A fuel-free region is provided within the core through which the liquid flows. An annular reflector surrounding the core is formed in segments, which are movable radially relative to the core. (A.G.W.)

27808 IMPROVEMENTS IN NUCLEAR REACTOR INSTALLATIONS. (to Babcock and Wilcox Ltd.). British Patent 984,692. Mar. 3, 1965. Priority date July 8, 1960, Germany.

A nuclear power reactor installation is designed to simplify gaseous fluid circulation through the reactor and through heat exchangers as required for power production. The heat exchangers are located not less than 50 m above the reactor, and upright riser and downcomer conduits carry the gaseous fluid between the reactor and the heat exchanger. The downcomer conduit surrounds the riser conduit to form an annular downcomer channel. The arrangement is adapted to effect coolant circulation by convection flow. (A.G.W.)

Production Reactors

27809 (HW-82797) PROCESS CONTROLLER SIMULATOR FOR FAST ANALOG SIMULATIONS. G. G. Thieme (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 1964. Contract AT(45-1)-1350. 23p. Dep.; $2.00(cy), 1(mn) CFSTI.

A versatile process controller simulator for the Hanford N-Reactor-plant was made which offers time scale speedup of 10 and more. The use of plug-in units (proportional + reset, proportional + derivative, and rate limiter) allows any configuration of controllers. The theory and operation of the units are discussed. The power supplies and equipment are described. (D.L.C.)

Propulsion and Space

See also ENGINEERING — Space Propulsion.

27810 (APS-5152-R1) QUARTERLY TECHNICAL PROGRESS REPORT ON SNAP 50/SPUR, FOR PERIOD ENDING DECEMBER 31, 1964. (Garrett Corp., Phoenix, Ariz. AiResearch Mfg. Div.). Jan. 18, 1965. Contracts AF33(615)-2289 and AF22(615)-1551. 86p.

Research and development on conversion-system components for the SNAP-50/SPUR Power unit are described. The information is presented in sections on development of bearings, materials, turbines, and heat transfer systems. Work on auxiliary power supplies is also reported. (J.R.D.)

27811 (ORNL-3775) MARITIME REACTOR PROGRAM ANNUAL PROGRESS REPORT FOR PERIOD ENDING NOVEMBER 30, 1963. (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 89p. Dep.; $3.00(cy), 2(mn) CFSTI.

ORNL assistance during the period to the Maritime Reactors Program included shipboard testing of filters for I_2 and particulate materials, I_2 absorption studies, analysis

of proposed reactor compartment ventilation changes, assistance in port surveys, studies of reactor safety, and advanced core development work. (J.R.D.)

27812 (SC-DC-65-1420) AEROSPACE NUCLEAR SAFETY PROGRAM AT SANDIA CORPORATION. Summary of a Speech. J. L. Colp (Sandia Corp., Albuquerque, N. Mex.). May 1965. Contract [AT(29-1)-789]. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The two types of systems for nuclear auxiliary power, radioisotopic and reactor systems, are discussed briefly. A program was initiated in 1961 to examine the safety of aerospace nuclear power sources. Brief summaries are presented of the scope of work involved in the following tasks: applied research and advanced development program, safety ground test program, safety flight test program, and system analysis and safety assessment program. (D.L.C.)

27813 (SC-RR-65-138) AN APPROXIMATE SOLUTION FOR THE VAPORIZATION OF LIQUID DROPLETS FORMED DURING RE-ENTRY ABLATION. R. N. Horton (Sandia Corp., Albuquerque, N. Mex.). Apr. 1965. Contract AT(29-1)-789. 21p. Dep.; $2.00(cy), 1(mn) CFSTI.

A mathematical model is described for solving the ultimate-particle-size problem by estimating the evaporative mass losses of molten droplets formed during reentry fusion. A computer program was written for solving the equations, and a sample calculation was made on a particular isotopic fuel form. (D.L.C.)

27814 (TID-21284) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE TORY II-C TESTS. (Southwestern Radiological Health Lab., Las Vegas, Nev.). Sept. 1, 1964. 17p. (SWRHL-10r). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Off-site surveillance was provided in support of the TORY II-C reactor tests conducted on May 12 and May 20, 1964. This support consisted of tracking the effluent, monitoring radiation dosage to the off-site population, and collecting environmental samples. The data collected indicate that no hazard to the off-site population was created as a result of the TORY tests. (auth)

27815 NUCLEAR SHIP PROPULSION. Euro Nucl., 2: 174-8(Apr. 1965).

The status of the main projects on nuclear propulsion for ships is summarized, including the German Otto Hahn project, the Dutch Nero project, the Norwegian Rederiatom project, and operating experience with the ice-breaker Lenin and the N. S. Savannah. (D.C.W.)

27816 COMPONENT TESTING UNDER SIMULATED SHIP OPERATING CONDITIONS. D. Ulken. Euro Nucl., 2: 179-82(Apr. 1965).

The "rolling-stand" used at the Geesthacht Research Center to test ship reactor components under simulated operating conditions is described, together with its operation. The first experiments performed at the facility are summarized. (D.C.W.)

Research and Test Reactors

27817 (EIR-73) UNTERSUCHUNG VON UNTERKRITISCHEN NATURURAN-SCHWERWASSERREAKTOREN MIT HILFE EINER GEPULSTEN NEUTRONENQUELLE. (Investigation of Subcritical Natural Uranium-Heavy Water Reactors Using a Pulsed Neutron Source). Erich Utzinger (Eidgenössisches Institut für Reaktorforschung Würenlingen (Switzerland)). Oct. 1964. 60p. Dep.(mn).

The time behavior of the neutron flux that originates when a neutron pulse is introduced into a subcritical reactor is a very sensitive analyzer for the absorbing and multiplying properties of the system. The possibilities of this method for heavy water-natural uranium systems was investigated. Measurements with various sub- and supercritical systems were carried out on the subcritical installation MINOR. The results were interpreted on the basis of the two-group diffusion theory and compared with theoretical data and experimental results from static studies. Methods to determine directly the multiplication factor or the reactivity of the system using delayed neutrons were investigated. The anisotropic thermal diffusion constants of systems consisting of pure heavy water with empty channels were measured using the pulsed neutron source. (tr-auth)

27818 (FZK-209) AN INVESTIGATION OF THE THERMAL RESPONSE OF THE AEROSPACE SHIELD TEST REACTOR TO LOSS OF COOLANT. R. A. Lawrence (General Dynamics/Fort Worth, Tex.). Apr. 1965. Contract AF29(601)-6213. 106p. (WL-TR-64-137).

An attempt was made to determine the possible consequence of a complete loss of coolant from the interior of a reactor, specifically the ASTR. The results are somewhat applicable to other reactors having similar materials and configurations. A heat-transfer model was developed and compared with experimental data. This comparison revealed that the model was conservative and that the heating rate and heat-loss rate were excessive. The experimental data were acquired from the ASTR in a series of tests that involved removal of the coolant from the reactor following operation at various power levels and operating times. It is concluded that operation conditions for threshold melting can be predicted and that fuel-element peak temperatures resulting from loss of coolant are relatively unaffected by the reactor being in either air or water. It is further concluded that overheated fuel elements can be cooled by adding water, with relatively little hazard of rupturing a fuel plate. (auth)

27819 (GA-5814) SUMMARY REPORT ON GENERAL ATOMIC IN-PILE LOOP OPERATIONS AND MODIFICATIONS. Richard F. Turner (General Atomic., San Diego, Calif.). Oct. 20, 1964. Contract AT(04-3)-167. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The GAIL (General Atomic In-pile Loop) facility in the GETR is described. The characteristics, operation, and modifications of this loop are discussed. (T.F.H.)

27820 (HW-69168(Suppl.)) PLUTONIUM RECYCLE CRITICAL FACILITY FINAL SAFEGUARDS ANALYSIS. SUPPLEMENT. F. Swanberg, ed. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Oct. 1964. Contract AT(45-1)-1350. 113p. Dep.; $4.00 (cy), 3(mn) CFSTI.

Supplement I, Additional Studies, reports the results of analyses of the nuclear characteristics of heavy-water-moderated PRCF cores including an all-plutonium fuel loading. The consequences of an excursion assuming failure of the safety circuit are presented. Moderator void formation and the negative fuel temperature coefficient of reactivity are shown to be sufficient to arrest the excursion. Heat transfer analyses of a short-cooled, preirradiated, plutonium–aluminum fuel element are reported assuming the fuel element in air with only convection cooling. Fuel temperatures in excess of the melting point of aluminum but less than the melting point of the Zircaloy-2 cladding of the fuel are indicated. It is postulated that the resultant stress would cause the Zircaloy-2 cladding to fail releasing radionuclides in the reactor cell. The consequences are estimated to be significantly less than those concluded from the study of the maximum credible accident reported in HW-69168. The consequences of the maximum credible accident, recalculated assuming unfiltered leakage from confinement, are reported. The results include the estimated quantity of plutonium deposition in off-site persons from inhalation of air-borne radioactive material, radiation exposure from released fission products, and the area in which it may be necessary to confiscate milk and produce. Supplement II, Analysis of Light Water Moderation, reports the detailed safeguards analyses for critical experiments with light water moderator in the PRCF. Analyses of nuclear excursions with PuO_2–UO_2 fuel to be used in the Experimental Boiling Water Reactor are reported. None of the postulated accidents result in fuel melting and

therefore there is no associated release of radionuclides. Limitations are stated which restrict operation of the PRCF to tests with mixed oxide fuels, moderator-to-fuel ratios which give zero or negative void coefficients of reactivity and reactor cores nominally 4 ft. high. Supplement III, Additional Studies– Light Water Moderation, extends the studies related to light water moderated cores with mixed oxide fuel. The enrichment level assumed is less than previously studied and reported in Supplement II (1.5% rather than 2.5% plutonium). The results of transient analyses with the lower enrichment are presented. Supplement IV, Analysis of Various Light Water Moderated Core Loadings, reports analyses of critical experiments planned for PRCF when modified for tests supporting the Plutonium Recycle Program. Results are reported for light-water-moderated plutonium–aluminum fuel loadings with enrichment levels of 1.8 and 5.0% plutonium. Additionally, analyses of PuO_2 fuel loadings with 1.8 wt% PuO_2 are reported. It is assumed that transients or excursions are either terminated by the safety system or terminated by the safety system or terminated by inherent negative reactivity effects when the safety circuit fails. Analog simulations reported indicate no perceptible fuel temperature rise when the transient is terminated by the safety system. When safety circuit failure is assumed, Doppler broadening is the principal overriding effect in ceramic fuel loadings. In metallic plutonium–aluminum fuel loadings, however, moderator boiling at the fuel element surface has almost immediate effect when the moderator void coefficient of reactivity is negative. The magnitude of the initial power peak is of the same order of magnitude for all fuel loadings studied and relatively independent of enrichment levels when safety circuit failure has been assumed. It is concluded that the consequences of credible accidents in light-water-moderated reactor configurations would be less severe than the maximum accident reported in Supplement I. (auth)

27821 (IDO-17064) A SUMMARY OF THE 1962 FUEL ELEMENT FISSION BREAK IN THE MTR. J. W. Dykes, J. D. Ford, and K. R. Hoopingarner (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Feb. 1965. Contract AT(10-1)-205. 11p. Dep.; $1.00(cy), 1(mn) CFSTI.

A piece of dislodged gasket material from the MTR primary coolant system caused a significant flow restriction in at least two flow channels of a standard MTR fuel element. Partial melting of one fuel plate resulted in the loss of approximately 10.5 grams of metal, containing an estimated 0.7 gram of fissionable material. Contamination of the primary coolant system was not severe, nor were any personnel overexposures received. (auth)

27822 (KN-685-63-1) FAST BURST REACTOR FACILITY. Final Safeguards Report. Kay B. Carver and T. G. Taxelius, eds. (Kaman Nuclear, Colorado Springs, Colo.). Dec. 1963. Contract DA-29-040-ORD-2919. 221p.

The FBRF is an enriched U-Mo alloy assembly, unmoderated and unreflected, designed to provide a maximum output of 2×10^{17} fissions per burst with a pulse width of 50 microseconds. It is also designed for steady-state operation at 10 kw. The FBRF provides an intense pulsed source of neutron and gamma radiation for radiation-effects testing. The design, control, and inherent features of the FBRF directed toward its safe operation are described; a brief description is also given of considerations of seismology, meteorology, geology, hydrology, terrain, and population density of the site and surrounding area. (M.J.T.)

27823 REACTOR TRANSIENTS AND REACTIVITY EFFECTS DUE TO AN EXTRANEOUS NEUTRON SOURCE. E. Pedretti (CNEN, Rome). Energia Nucl. (Milan), 12: 254-65(May 1965).

The time behavior of a zero power reactor, when an extraneous neutron source is put into or removed from its core, was described by introducing the source reactivity effect into the one-energy group, space independent, kinetic equations. Detailed calculations were performed by an IBM 1620 computer to investigate source insertion and removal transients. Time behaviors of neutron density, precursors concentrations, and inverse reactor period are reported for five cases of particular significance. Methods for the experimental determination of the source reactivity effect were developed and used in reanalyzing previously published experimental data. It was found that the reactivity effect due to the insertion of one curie Ra–Be neutron source into a swimming-pool reactor core was comprised between $-(68.55 \pm 2.40) \times 10^{-5}$ and $-(2.50 \pm 0.08) \times 10^{-5}$, depending on the source position. The possibility of establishing a new technique for the measurement of the effective prompt neutron generation time is pointed out. (auth)

27824 THE OSIRIS RESEARCH REACTOR. I. GENERAL PRESENTATION. II. DESIGN AND DESCRIPTION. B. Lerouge. Energie Nucl., 7: 3-16(Jan.-Feb. 1965). (In French)

Osiris, the swimming pool reactor being built at Saclay, is to be used principally for tests, under a high flux of fast neutrons, of reactor structure materials for future nuclear power stations. This reactor was designed to be adapted to the experiments foreseen. The program for use of the reactor and the reasons for choosing the general characteristics are discussed. A comparison was made between Osiris and the test piles already working at C.E.A., Siloé and Pégase. The reactor and auxiliary equipment are described and research aims are outlined–flexibility of use, continuity and safety in operation, and the working facility are considered. Diagrams of the reactor and the related installations are included. (auth)

27825 IRRADIATION FACILITY USING A NaK CAPSULE, INSTALLED IN JRR-2, AND THE RADIATION SAFETY. Kiyoaki Taketani (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 10: No. 7, 33-7(July 1964). (In Japanese)

A NaK capsule containing an irradiation sample is sent to the reactor core for irradiation through the irradiation tube running through the reactor wall, which is part of the irradiation facility called the EFTL-2. The EFTL-2 also includes, besides the irradiation tube, a specimen holder, a cooling device, a gas-tight chamber, pipings and valves, and a calculator. For protection against radiation leaking out of the reactor core, thicknesses of the shielding walls involved were carefully calculated. (NSA of Japan)

27826 PLUG HANDLER FOR THE JRR-3. Keizo Wase and Miyoshi Hagiya (Hitachi, Ltd., Tokyo). Hitachi Hyoron, 46: 777-80(May 1964). (In Japanese)

The JRR-3 has 8 horizontal experimental holes used in beam tests and 7 horizontal holes for measuring the reactor characteristics. Plugs were used in these holes for shielding against radiation. A plug handler for the plugs of JRR-3 was constructed by Hitachi, Ltd., for the JAERI; it is used in the insertion and storing of the plugs. Because of the narrow space around the reactor where the handler operates, difficulties were encountered in the design. To obtain the fine adjustment of the plugs inserted by the handler, slide bearings of steel and teflon surfaces were used. Since the friction coefficient between the surfaces is as low as 0.08, no stick-slip effect occurs. The handler has an automatic locator consisting of a centering device and die-head. The die-head is equipped with a limit switch connected to the four feelers around the centering device. (NSA of Japan)

27827 THE LIVERPOOL AND MANCHESTER UNIVERSITIES RESEARCH REACTOR. H. Bridge, W. B. Hall, and D. E. Jeffers (Univ. of Manchester, Eng.). J. Brit. Nucl. Energy Soc., 4: 85-96(Apr. 1965).

A brief description of the Liverpool and Manchester Universities Research Reactor is given, and the safety assessment of such reactors are considered, along with an appraisal of the experimental facilities from the user's viewpoint. A brief discussion of operating experience is also included. Measured core characteristics and documentation are appended. (P.C.H.)

27828 TRAINING SUB-CRITICAL ASSEMBLY AND THE POSSIBILITIES OF ITS USE. Ladislav Drska and Bedrich Hermansky (Fakulta Technicke a Jaderne Fyziky CVUT, Prague). Jaderna Energie, 11: 128-39(1965) (In Czech)

Fundamental characteristics of some subcritical assemblies for training are summarized and the choice of equipment is considered. Conclusions from a detailed design study of a subcritical assembly of natural uranium and light water are presented. This assembly was equipped with a spacing device and actuated with a high-efficiency neutron generator. The main results of detailed physical calculations of this assembly are reported and the possibilities of its use in training personnel in the physical fundamentals of nuclear science are evaluated. (auth)

27829 REARRANGEMENT OF THE CORE IN THE VVRS-REACTOR. Lajos Varkonyi. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 13: 41-7(1965). (In Hungarian)

Since the burnup and scorification rate varies with the position of the individual fuel element assemblies within the reactor core, some rearrangements have to be made in the core from time to time in order to ensure maximum utilization of fuel elements. A method is described by which the replacement of fuel element assemblies and the rearrangement of the core can be performed under optimum conditions. (auth)

27830 SHORT TIME-VARIANCE METHOD FOR PROMPT-NEUTRON-LIFETIME MEASUREMENTS. Nicola Pacilio (CNEN-CSN Casaccia, Rome). Nucl. Sci. Eng., 22: 266-7(1965).

Previous theoretical considerations of the neutron population and experimental values of correlated variance as a function of counting time are briefly discussed. A short time-variance method for prompt-neutron-lifetime measurements is outlined. This method was applied in measuring the prompt-neutron lifetime in the organic-moderated ROSPO reactor at CSN, and the results obtained were in good agreement with previous measurements and calculations. (C.E.S.)

WASTE DISPOSAL AND PROCESSING

See also BIOLOGY AND MEDICINE — Ecology.
CHEMISTRY — Radiochemistry.
CHEMISTRY — Separation Processes and Procedures.
HEALTH AND SAFETY.

Refer also to abstract 26219.

27831 (AE-182) THE HANDLING OF LIQUID WASTE AT THE RESEARCH STATION OF STUDSVIK, SWEDEN. S. Lindhe and P. Linder (Aktiebolaget Atomenergi, Studsvik (Sweden)). Mar. 1965. 17p. Dep.(mn).

The following quantities of radioactive waste are allowed to be released into a strait between the islands of Stora Bergö and Studsviksholme: total α-activity = 0.2 Curie/month and total β-activity = 36 Curie/month, of which cerium, yttrium, rare earths = 15 Curie/month and strontium = 2.4 Curie/month. Before the release the radioactive waste has to be collected and controlled. Quantities approaching or exceeding the disposal limits have to be removed and concentrated by evaporation. The liquid waste is classified in several categories depending upon the level of activity: high active and medium active waste, low active waste, process water, sanitary water, surface water and reactor cooling water. The technical dimensioning of each category was based upon expected specific production figures (volume/man · month and activity/ man · month). These figures are based upon information obtained from Harwell. Actual production figures obtained during 1963 and the first half of 1964 are shown and compared with the expected ones. As a conclusion, it is stated that the actual production follows the predictions fairly well. (auth)

27832 (HW-83609) PROGRESS IN FISSION-PRODUCT RECOVERY AT HANFORD. A SUMMARY OF HANFORD LABORATORIES ACHIEVEMENTS IN THIS PROGRAM UNDER GENERAL ELECTRIC, 1954-1964. R. L. Moore (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 1964. Contract AT(45-1)-1350. 28p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Development of processes for Cs, Sr, Ce, Pm, and Tc recovery is summarized. Discussions are included concerning the CSREX process, waste management, and isotope production. A bibliography of 78 references is included. (J.R.D.)

27833 (HW-83610) PROGRESS IN RADIOACTIVE RESIDUE PROCESS DEVELOPMENT. A Summary of Hanford Laboratories Achievements in This Program Under General Electric, 1958-1964. A. M. Platt and C. R. Cooley (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 1964. Contract AT (45-1)-1350. 36p. Dep.; $2.00(cy), 1(mn) CFSTI.

Results are summarized for studies on high-level waste calcination, hot cell pilot plants, waste solidification, and methods for intermediate-level waste treatment. (J.R.D.)

27834 (IDO-12040) RADIOACTIVE WASTE DISPOSAL DATA FOR THE NATIONAL REACTOR TESTING STATION. Joe H. Osloond (Idaho Operations Office (AEC), Idaho Falls. Health and Safety Div.). April 7, 1965. 36p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

A summary is presented of the data pertaining to the disposal of radioactive waste at the National Reactor Testing Station. The volumes of liquid, gaseous, and solid wastes are reported with the concentration and total amounts of contained nuclides given. Detailed information is listed for the years 1962 through 1964. Yearly summary totals are listed for the years since 1955. (auth)

27835 (ORNL-TM-1108) GEOLOGY AND SOILS OF WHITEOAK CREEK BASIN, TENNESSEE. W. M. McMaster and H. D. Waller (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 36p. Dep.(mn); $2.00 (cy), 1(mn) CFSTI.

Since Oak Ridge National Laboratory began operation in 1943, radioactive wastes have been released on a continuous basis to the environment of Whiteoak Creek Basin. The natural factors affecting movement or retention of the radionuclides released are the water moving in and through the basin and the materials over and through which the water and its associated radionuclide load pass in transit. Because the geology and soils of Whiteoak Creek Basin are the principal modifying agents in water movement and the soil selectively fixes radionuclides, a knowledge of their characteristics is necessary for an understanding of the manner in which radionuclides move through or are stored in the basin. The geologic setting, the characteristic soils, and the general hydrologic characteristics of the geology and soils of the basin are described. (C.H.)

27836 THE INCINERATION OF RADIOACTIVE WASTES AND ITS INDUSTRIAL ASPECTS. Jean Rodier, Guy Leifillatre, and Michel Charbonneaux. Energie Nucl., 7: 25-37(Jan.-Feb. 1965). (In French)

The incineration of radioactive waste considerably reduces their volume and this is especially necessary in countries with a small area and a high population density. The principles of the design of the incineration unit project at the Marcoule Centre (where the solid wastes are the most abundant) are reviewed along with the factors that determine the choice of the installation characteristics; the importance of the problems of corrosion, fire, and the necessity of purifying the gas formed are emphasized. A description of the installation is given as well as some data on the efficiency of the gas purifying system, on the operation of the installation in general, and on operational costs. (auth)

27837 RADIOACTIVE CONTAMINATION OF THE SEA. Masamich Saeki (National Inst. of Radiological Sciences, Chiba, Japan) and Katsuko Saruhashi. Genshiryoku Kogyo, 10: No. 7, 7-29(July 1964). (In Japanese)

Several articles presented under the title heading include the following: The disposal of radioactive wastes into the sea (by Saeki): the present state and future of radioactive wastes in Japan, treatment and disposal of wastes, disposal into the sea and coastal waters, disposal of solid waste packages into the deep sea, and disposal into river waters. Radioactive contamination of the sea (by Saruhashi): contamination in the northern Pacific, ^{137}Cs and ^{90}Sr in surface waters, vertical distribution of these isotopes, disposal into the deep sea, and problems. Radioactive contamination of marine products (by Hiyama): effect of sea contamination on marine products, uptake of radioactive isotopes (RI) by marine organisms, concentrations of RI in marine organisms, disposal by dilution and isolation, protection against the radiations, and necessity of the law that controls sea contamination. Nuclear-powered ships and contamination of the sea (by Hattori): reactors used in nuclear-powered ships, radioactive wastes from the ships, disposal of wastes into the sea, and accidents. Radioactive contamination of the sea and international law (by Oda): the progress of the law panel of IAEA started in January 1961. (NSA of Japan)

27838 RADIOACTIVE CONTAMINATION OF THE SEA. Katsuko Saruhashi (Meteorological Research Inst., Japan). Genshiryoku Kogyo, 10: No. 7, 12-17(July 1964). (In Japanese)

The migration of the center of contamination in the northern Pacific during the period June 1954–August 1955 is described. The concentrations of ^{137}Cs and ^{90}Sr in the northwestern Pacific decreased and became uniform during 1957–1962, while the ^{137}Cs concentration in the northeastern Pacific increased during 1959–1962. The vertical distribution of ^{137}Cs and ^{90}Sr is discussed, especially for the diffusion process. The rates of leakage or diffusion into the surface waters for a period of 100 years are calculated for ^{90}Sr packaged or not packaged and then disposed into the deep sea (4000 m deep). Factors influencing the behaviors of radioactive substances in the sea are also described. (NSA of Japan)

27839 PERERABOTKA I ZAKHORONENIE RADIOAKTIVNYKH OTKHODOV LABORATORII. (Processing and Disposal of Radioactive Waste from Laboratories). E. Ya. Spitsyn. Moscow, Atomizdat, 1965. 132p.

Problems in the processing, transportation, and disposal of radioactive waste from laboratories and industries handling radioactive materials are discussed. Methods of disposal used in the USSR and abroad are analyzed. (R.V.J.)

27840 THE MANAGEMENT OF RADIOACTIVE WASTES PRODUCED BY RADIOISOTOPE USERS. (International Atomic Energy Agency, Vienna (Austria)). 1965. Safety Series No. 12. 59p. $1.50; S 31,50; 9/-stg; F.Fr.6,-; DM 4,80 (IAEA). (STI/PUB/87)

A code of practice is presented for the handling of the small quantities of waste produced by the use of radioisotopes in laboratories. The chapters deal respectively with the control of radioisotope uses and waste disposal, waste management by individual users of radioisotopes, waste management in a large central facility, and waste storage and containment. The types of waste associated with some radioisotope uses and examples of national regulations are appended. (D.L.C.)

GENERAL AND MISCELLANEOUS

27841 (ALO-487A-1) A HYDROSTATIC PRESSURE MEASURING DEVICE FOR HIGH EXPLOSIVES. J. D. Harrell (Mason and Hanger–Silas Mason Co., Inc., Amarillo, Tex.). [1964]. Contract DA-11-173-AMC-487(A). 24p. (CONF-650503-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Experimental Stress Analysis Association, Denver.

An electrical device was developed for measuring the actual pressure in various parts of a piece being compacted. The device uses clay-graphite type resistors, and some calibration data are given. An attempt to plot contours of the pressure produced in a billet of PBX 9404 explosive during compaction showed definite evidence of nonuniform pressure distribution. (D.L.C.)

27842 (CU-2663-20) DYNAMICS OF GULF STREAM MEANDERS. Takashi Ichiye (Lamont Geological Observatory, Columbis Univ., Palisades, N. Y.). Apr. 1965. Contracts AT(30-1)-2663, NSF GP 1806, and Nonr 266(48). 92p. (CU-1806-3; CU-266(48)-13). Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Hydrodynamical theories on meanders of the Gulf Stream and similar western boundary currents are critically reviewed. Observed facts of meanders east of Cape Hatteras are described including data obtained in Operation Cabot and Gulf Stream '60. Long waves along a shearing horizontal current in a rotating barotropic system are discussed, based on Haurwitz and Panofsky's model. Stability of long waves in a uniform current of a two-layer ocean is treated from Stommel's and Iida and Ichiye's theory. Theories on waves on a shearing current in the upper layer of a two-layer including Duxbury, Iwata and Yasui are presented. General criteria on stability of a baroclinic flow are discussed, including Pedlosky's application of Lin's theorem. The Rossby waves in a barotropic and baroclinic ocean are explained by various authors including Fofonoff, Moore, Il'in and Kamenkovich, Welander and Ichiye, and instability of waves in an eastward flow is discussed as a cause of meanders. Applications of Rossby's constant absolute trajectory theory to meanders by Saint-Guily, Warren and Ichiye are presented, and Greenspan's criterion on stability of a western boundary current is derived. The cross current momentum eddy transfer determined by Webster and Ichiye for the Gulf Stream and the Kuroshio, respectively and the eddy heat transfer determined by Oort for the Gulf Stream are discussed. Possibility of testing some theories on meanders by use of a rotating tank is discussed on the basis of Faller's explanation of similarity between β-effect and variable depth. The observed facts of meanders of the Kuroshio are presented from results of Masuzawa, Morivasu, Uda and Ichive. (auth)

27843 (DP-929(Suppl.1)) PUBLICATIONS, 1964. H. S. Hilborn, comp. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Feb. 1965. Contract AT(07-2)-1. 19p. Dep.; $1.00(cy), 1(mn) CFSTI.

A compilation is presented of research and development reports, journal articles, contributions to books, computer programs, and other items published in 1964. Bibliographic, subject, and author listings are included. (D.L.C.)

27844 (EGG-1183-64) TRANSIENT RESPONSE TO THE TEM PRIMARY WAVE IN RADIAL TRANSMISSION LINE. Melvin M. Weiner (Edgerton, Germeshausen and Grier, Inc., Boston, Mass.). [Apr. 21, 1964]. Contract AT(29-1)-1183. 28p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Analysis of the time response for the TEM primary wave in radial transmission line with impulse, step, and ramp excitations at the center is extended by means of a Green's function formulation to the more general case of a circular distribution of point sources about the center. Some inverse Laplace transforms are evaluated for modified Bessel functions of the form $K_n(as)\ I_m(-bs)$. (auth)

27845 (HW-83854) RADIOTELEMETERING NETWORK DATA STATIONS INSTRUCTION MANUAL. C. A. Ratcliffe and E. M. Sheen (General Electric Co. Richland, Wash. Hanford Atomic Products Operation). Sept. 24, 1964. Contract AT(45-1)-1350. 46p. Dep.(mn); $2.00 (cy), 1(mn) CFSTI.

An instruction manual for operation and servicing meteorological-radiological telemetering stations is presented. Instrumentation, component, and assembly drawings are included. (T.F.H.)

27846 (HW-84617) HANFORD FORMAL RESEARCH AND DEVELOPMENT REPORTS, 1964. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Jan. 1965. Contract AT(45-1)-1350. 35p. Dep.; $2.00 (cy), 1(mn) CFSTI.

Research and development reports published during 1964 by the Technical Information Operation of the Hanford Atomic Products Operation are listed. Availability and complete bibliographic information is given for each report. The categories include biology and medicine, chemistry, engineering and equipment, general, health and safety, instruments, mathematics and computers, metals, ceramics, and materials, meteorology, physics, and reactor technology. A separate list of progress reports and author and report number indexes are also included. (P.C.H.)

27847 (HW-SA-3540) A NOTE ON THE MATING RITUAL AND BIOLOGY OF ELEODES HISPILABRIS CONNEXA LE C. (COLEOPTERA, TENEBRIONIDAE). L. E. Haverfield (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). [May 22, 1964]. Contract AT(45-1)-1350. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Observations are reported on the biology and mating habits of Eleodes hispilabris connexa in the field and in the laboratory. (C.H.)

27848 (K-DP-515) TABLE LOOK-UP TECHNIQUES FOR COMPUTER PROGRAMMING. C. E. Price (Oak Ridge Gaseous Diffusion Plant, Tenn.). May 13, 1965. Contract W-7405-eng-26. 21p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Techniques for looking up information in a table from a computer programing standpoint are described. Various techniques are introduced and explained and criteria for selecting a technique in a given application are considered. Attempts were also made to draw some guidelines for technique selection. (P.C.H.)

27849 (LA-DC-6372) A PARTIAL ANALYSIS OF GO. Edward O. Thorp (New Mexico State Univ., University Park. Mathematics Dept.) and William E. Walden (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1962]. Contract [W-7405-eng-36]. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A game called Computer Go is defined. Computer Go differs from the game of Japanese Go only in that certain imprecisely defined conventions have been replaced by precise rules. Some general theorems on Computer Go are given, as well as a scheme for analyzing the game with the aid of a computer. Several reduced versions of Computer Go were analyzed and the resultant strategies are briefly described. (auth)

27850 (LADC-6477) ON POLYNOMIAL EQUATIONS WITH COEFFICIENTS EQUAL TO THEIR ROOTS. Paul R. Stein (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract [W-7405-eng-36]. 5p. Dep. (mn); $1.00(cy), 1(mn) CFSTI.

The determination of fixed points for polynomial equations is considered. It is shown that no polynomial equations of degree $n \geq 5$ exist whose real coefficients are all different from zero and equal to their roots. The special cases $n \leq 4$ are considered individually. (D.L.C.)

27851 (NYO-1018-3) POLAR-NONPOLAR OR AMPHIPATHIC INORGANIC COMPOUNDS. Final Report. Ulrich P. Strauss (Rutgers—The State Univ. of New Jersey, New Brunswick). Apr. 30, 1965. Contract AT(30-1)-1018. 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The results of studies of the molecular structure, interactions with cations, and hydrolytic stability of inorganic polyphosphates are summarized briefly. The structure was found to be chain-like; the branching points hydrolyze rapidly relative to the linear chains so that after a while in water, all the chains are linear. The polyphosphates were also found to have very powerful sequestering action on cations. (D.L.C.)

27852 (NYO-10722) STRAIN-ENHANCED SELF-DIFFUSION IN SILVER (thesis). Final Report. Gordon Lloyd Fisher (Pennsylvania Univ., Philadelphia). 1965. Contract AT(30-1)-1879. 157p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

Silver single crystals were prepared and machined into torsion specimens, and the specimens were plated with ^{110m}Ag tracer. Diffusion anneals were carried out at 550 to 800°C with the specimens under cyclic torsion strain, and the specimens were then sectioned to determine the amount of diffusion. When errors produced by sectioning and surface roughness were taken into account, the enhancement of the self-diffusion coefficient was small, exceeding 100% in only one case. The experiments of Lee and Maddin were repeated, and it is concluded that their high enhancements were due to the use of torsion in one direction. The homogeneity of cyclic torsion strain was found to be uniform. The results are compared with previous work, and an attempt is made to find the cause of the enhancements. (D.L.C.)

27853 (ORNL-P-1212) NADH PEROXIDASE. M. I. Dolin (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 31p. (CONF-650609-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From Symposium on Flavins and Flavoproteins, Amsterdam.

The spectral intermediate that is formed on addition of NADH to NADH peroxidase has the characteristics of an enzyme-substrate complex. The spectral change that accompanies complex formation consists of partial bleaching of the 450 mu band and formation of a broad absorption band centered at about 540 mu. This 2-banded spectrum is characteristically produced by pyridine dinucleotides that are peroxidase substrates. Those pyridine dinucleotide analogues that are not substrates do not elicit the typical absorption changes. Two pyridine nucleotides (NMNH and NADPH) cause the formation only of the 450 mu band. These compounds are poor peroxidase substrates, but they share with active substrates the ability to serve as electron donors for the very weak oxidase activity of the enzyme. For those pyridine nucleotides which have measurable enzyme activity, there is good correspondence between the dissociation constant of the binary enzyme-substrate complex and the Michaelis constant derived from kinetic studies. These qualitative and quantitative correlations suggest that the complex is a catalytically active species. The investigation has not provided unequivocal evidence for the reduction state of the complex. (auth)

27854 (PNE-402) PROJECT CHARIOT—ENVIRONMENTAL PROGRAM. Preliminary Report. (Alaska Univ., College. Dept. of Biological Sciences). Dec. 6, 1960. 44p. Dep.(mn); $2.00(cy), 0(mn) CFSTI.

Ornithological investigations were conducted in the Cape Thompson region of northern Alaska during 1960. Data are presented on species composition, ecological distribution, population density, productivity, and seasonal movements of birds of the area. (C.H.)

27855 (PNE-408) MAMMAL INVESTIGATIONS—CARIBOU. Supplementary Progress Report. Peter C. Lent (Alaska Univ., College). Jan. 4, 1960. Contract AT(04-3)-310. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Data are presented on the number and movement of caribou herds in the Cape Thompson area, Alaska, during the winter of 1959-1960. (C.H.)

27856 (PNE-409) CARIBOU INVESTIGATIONS, NORTHWEST ALASKA. Interim Final Report. Peter Lent (Alaska Univ., College). June 1960. Contract AT(04-3)-310. 72p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Data are presented from an ecological study of caribou (Rangifer arcticus) in the Cape Thompson area of Alaska. Data are included on number, distribution, and mixing of herds during early 1960. (C.H.)

27857 (PNE-410) CARIBOU INVESTIGATIONS, NORTHWEST ALASKA. Progress Letter. Peter C. Lent (Alaska Univ., College). Sept. 1960. Contract AT-(04-3)-310. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Data are presented on the number, reproduction, and herd movement of caribou in the Cape Thompson area of Alaska between May 1 and Aug. 25, 1960. (C.H.)

27858 (PNE-411) CARIBOU INVESTIGATIONS, NORTHWEST ALASKA. Phase III, Progress Report. Peter C. Lent (Alaska Univ., College. Dept. of Biological Sciences). Dec. 1960. Contract AT(04-3)-310. Project CHARIOT. 71p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Data are presented from ecological studies on caribou of the Cape Thompson area, Alaska. The relation of snow cover and meteorological factors on food supplies and population movement as observed during 1960 is discussed. (C.H.)

27859 (PNE-412) CARIBOU INVESTIGATIONS, NORTHWEST ALASKA. Phase III, Progress Report. Peter C. Lent (Alaska Univ., College. Dept. of Biological Sciences). June 1961. Project CHARIOT. 37p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

Data are presented on the number, reproduction, and herd movement of caribou in the Cape Thompson area of Alaska from Sept. 1960 through April 1961. (C.H.)

27860 (PNE-413) TERRESTRIAL MAMMALS INVESTIGATION, OGOTORUK CREEK-CAPE THOMPSON AND VICINITY. PART C. CARIBOU INVESTIGATIONS, NORTHWEST ALASKA. Final Progress Report. Peter C. Lent and Odd Loenoe (Alaska Univ., College. Dept. of Biological Sciences). May 1962. Contract AT(04-3)-310. 49p. Project CHARIOT. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

Data are presented on the number, diet, reproductive rate, and herd movement of caribou in the Cape Thompson area, Alaska, during 1961 and 1962. (C.H.)

27861 (PNE-414) TERRESTRIAL MAMMALS INVESTIGATION, OGOTORUK CREEK-CAPE THOMPSON AND VICINITY. SUPPLEMENT TO FINAL REPORT, PART C. CARIBOU INVESTIGATIONS, NORTHWEST ALASKA, MAY 21 TO JULY 5, 1962. Peter C. Lent (Alaska Univ., College. Dept. of Biological Sciences). Oct. 1962. Contract AT(04-3)-310. 11p. Project CHARIOT. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Data are presented from field studies of caribou calving in the Cape Thompson area of Alaska in the spring of 1962. Data on the ecology and behavior of caribou of the region are included. (C.H.)

27862 (PNE-415) ANALYSIS OF PLANT MATERIALS IN THE RUMEN OF CARIBOU OF NORTHWESTERN ALASKA. Final Report. Lloyd H. Swift and Richard H. Bishop (Alaska Univ., College. Dept. of Biological Sciences). June 1963. Contract AT(04-3)-310. 31p. Project CHARIOT. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Data are presented from an ecological study of caribou of the Cape Thompson-Cape Seppings area of Alaska made from 1960 through 1962. Results are reported from an analysis of plant material in the rumen of caribou to determine the percentages of lichen, moss, and vascular plant material in the diet. (C.H.)

27863 (PNE-416) OGOTORUK VALLEY—MAMMAL INVESTIGATIONS. Progress Report. William O. Pruitt, Jr. (Alaska Univ., College). Dec. 1959. Contract AT(04-

3)-310. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Progress is reported in studies of the ecological relations of mammalian species in the terrestrial food chain of the Ogotoruk Valley, Cape Thompson area, Alaska. Emphasis was placed on the role of caribou in the region, migratory movements, and population dynamics in 1959. (C.H.)

27864 (PNE-417) OGOTORUK VALLEY MAMMAL INVESTIGATIONS. Interim Final Report — Phase II. William O. Pruitt, Jr., Peter C. Lent, and Barbara Murray (Alaska Univ., College). June 1960. Contract AT-(04-3)-310. 95p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Data are presented from ecological studies on small mammals of the Cape Thompson area, Alaska, made during 1959 and 1960. Data are included on population dynamics, vegetational associations, and influence of environmental factors on animal populations. (C.H.)

27865 (PNE-418) TERRESTRIAL MAMMAL INVESTIGATIONS, OGOTORUK CREEK, CAPE THOMPSON AND VICINITY. Phase III, Progress Report. William O. Pruitt, Jr., Peter C. Lent, and Ernest A. Carl (Alaska Univ., College. Dept. of Biological Sciences). Dec. 1960. Contract AT(04-3)-310. Project CHARIOT. 46p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Data are presented from a study on the ecology of mammals of the Ogotoruk Creek area, Cape Thompson, Alaska, made in 1960. Emphasis was placed on the population dynamics of caribou, Rangifer arcticus, and the arctic ground squirrel, Citellus parryii. (C.H.)

27866 (PNE-419) TERRESTRIAL MAMMAL INVESTIGATIONS, OGOTORUK CREEK, CAPE THOMPSON AND VICINITY. Phase III, Progress Report. William O. Pruitt, Jr., Peter C. Lent, Ernest A. Carl, and Barbara Murray (Alaska Univ., College. Dept. of Biological Sciences). June 1961. Contract AT(04-3)-310. Project CHARIOT. 58p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Data are presented from an ecological study of mammals of the Cape Thompson, Alaska, area made in 1961. Emphasis was placed on the ecology of the arctic ground squirrel, Citellus parryii in the Ogotoruk Creek area. (C.H.)

27867 (PNE-430) INVESTIGATIONS OF SEA-CLIFF BIRDS, CAPE THOMPSON, ALASKA. Project Chariot — Phase III, Progress Report. L. G. Swartz and G. W. Cox (Alaska Univ., College. Dept. of Biological Sciences). June 1961. Contract [AT(04-3)-310]. 40p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Results are summarized from studies of the breeding biology, behavior, and ecology of important species of sea-cliff birds of the Cape Thompson, Alaska area. (C.H.)

27868 (PNE-431) INVESTIGATION OF SEA-CLIFF BIRDS, CAPE THOMPSON, ALASKA. Final Report. L. Gerard Swartz (Alaska Univ., College. Dept. of Biological Sciences). May 1964. Contract AT(04-3)-310. 133p. Project CHARIOT.

Approximately 7 miles of precipitous coastline between Ogotoruk Creek and Point Hope, in the Cape Thompson area of Alaska, support over 400,000 colonial sea birds. These sea-bird colonies are the most dramatic biotic feature of the area and they exert a major influence on the ecosystem. Data are presented on the ecology and breeding biology of the sea birds, on species composition and abundance of the sea-bird fauna, and on the components and dynamics of the sea-bird ecosystem at Cape Thompson. (33 references) (C.H.)

27869 (PNE-432) OGOTORUK VALLEY BOTANICAL PROJECT. Progress Report. A. W. Johnson, L. A. Viereck, and H. R. Melchior (Alaska Univ., College). Dec. 1, 1959. Contract AT(04-3)-310. 139p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Progress is reported in a study of plant ecology in the Ogotoruk Valley, Cape Thompson area, Alaska, made in 1959. It is pointed out that this portion of Alaska may hold the answer to phytogeographical problems related to the existence of a Pleistocene land bridge between North America and Asia in this unglaciated portion of the arctic. Preliminary studies indicate that this area contains overlapping elements of the Bering Coast flora, the Arctic coast flora, and the Brooks Range flora, with the additional possibility of a few advents from the Rocky Mountain flora. Data on the composition and ecology of the vegetation of the area are summarized. (56 references) (C.H.)

27870 (PNE-433) OGOTORUK VALLEY BOTANICAL PROJECT, PHASE II. Interim Final Report, June 1960. A. W. Johnson, L. A. Viereck, and H. R. Melchoir (Alaska Univ., College). 44p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Data are presented from an ecological study of plants of the Ogotoruk Valley, Cape Thompson area, Alaska, made in 1959 and 1960. Lichens, mosses, liverwarts, and vascular plants were identified. Data are included from studies of seed germination and the effects of snow conditions and wind direction and velocity on plant distribution. (C.H.)

27871 (PNE-434) OGOTORUK CREEK BOTANICAL INVESTIGATIONS, CAPE THOMPSON, ALASKA. Phase III, Progress Report. L. A. Viereck, R. E. Johnson, and H. R. Melchior (Alaska Univ., College. Dept. of Biological Sciences). Dec. 1960. 104p. Project CHARIOT. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Progress is reported in a study of plant ecology in the Ogotoruk Valley, Cape Thompson area, Alaska, made in 1960. The vegetation of the Valley was separated into 10 major and a number of minor types. Several of the major types were divided into subtypes on the basis of apparent differences in species composition or conspicuous differences in patterned ground features. Quantitative data on vegetation, meteorological factors, and geological factors are summarized. Data are included from studies of the relation of the activities of the arctic ground squirrel, Citellus parryii, and vegetation in the Valley. (C.H.)

27872 (PNE-435) OGOTORUK CREEK BOTANICAL INVESTIGATIONS. PRELIMINARY STUDIES ON THE INFLUENCE OF FROST ACTION AND RELATED PHENOMENA ON THE VEGETATION OF THE OGOTORUK CREEK VALLEY. Phase III, Progress Report. Albert W. Johnson (Alaska Univ., College. Dept. of Biological Sciences). Dec. 1960. 67p. Project CHARIOT. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Data are presented from preliminary studies on the influence of frost and related features of the arctic environment on the vegetation of the Ogotoruk Creek Valley, Cape Thompson area, Alaska. Ground features are described and vegetation-frost relations are presented for typical wet meadow, tussock, and frost scar plant communities. The relation of ground features to vegetation types and plant succession and climax in the Ogotoruk Valley are discussed. (C.H.)

27873 (PNE-436) OGOTORUK CREEK BOTANICAL INVESTIGATIONS, CAPE THOMPSON, ALASKA. PART A. Phase III, Progress Report. L. A. Viereck and R. E. Johnson (Alaska Univ., College. Dept. of Biological Sciences). June 1961. 74p. Project CHARIOT. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

Progress is reported in a study of plant ecology in the Ogotoruk Valley, Cape Thompson area, Alaska, made in 1960. Data are presented on the various vegetation types and communities of the Ogotoruk Creek drainage system. Results are included from a study of the inter-relation of activities of the arctic ground squirrel, Citellus parryii, and vegetation in the valley. (C.H.)

27874 (PNE-437) OGOTORUK CREEK BOTANICAL INVESTIGATIONS, CAPE THOMPSON, ALASKA. PART B. THE EFFECTS OF ARCTIC GROUND SQUIRRELS ON THE VEGETATION OF OGOTORUK CREEK VALLEY. Phase III, Progress Report. Herbert R. Melchior (Alaska Univ., College. Dept. of Biological Sciences). June 1961. Contract AT(04-3)-310. Project CHARIOT. 39p. Dep.(mn): $2.00(cy), 1(mn) CFSTI.

A survey of vegetation of Ogotoruk Creek Valley, Cape

Thompson area, Alaska, in 1960, led to the conclusion that the behavior of the arctic ground squirrel, Citellus parryii, is an important factor in the distribution of vegetation. The increased growth of burrow-associated plants was attributed to the churning and loosening of the soil, fertilization, and dropping of seeds around the burrows during burrowing and feeding. These activities were observed to be influenced by such environmental phenomena as depth of permafrost, topography, drainage, and spatial distribution and life form of the vegetation used to provide food or nest materials. (C.H.)

27875 (PNE-438) OGOTORUK CREEK BOTANICAL INVESTIGATIONS — INFLUENCE OF FROST ACTION ON THE VEGETATION OF OGOTORUK CREEK VALLEY. Final Progress Report. Bonita J. Neiland, Albert W. Johnson, and Ross E. Johnson (Alaska Univ., College. Dept. of Biological Sciences). June 1962. Contract AT-(04-3)-310. 51p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Data are presented from studies of plant ecology in the Ogotoruk Creek Valley, Cape Thompson area, Alaska. Emphasis was placed on the influence of frost action on the vegetation of the area. (C.H.)

27876 (PNE-465) 1961 SALMON SURVEY, PROJECT CHARIOT. (Washington Univ., Seattle. Lab. of Radiation Biology). Contract AT(45-1)-540. 11p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

Data are presented on the number and distribution of salmon and other fish in the Cape Thompson area, Alaska, during the summer of 1961. (C.H.)

27877 (SC-DC-64-1835) ADVANCE AND PRIME GENERATOR FOR DRIVING DIGITAL MAGNETIC LOGIC. E. J. Bernard and T. A. Howard (Sandia Corp., Albuquerque, N. Mex.). [Oct. 1964]. Contract [AT(29-1)-789]. 13p. (CONF-650403-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From International Conference on Non-Linear Magnetics, Washington, D. C.

A temperature stable, self-timed, pulse generator is presented which operates from a low voltage power supply and utilizes the characteristics of a square loop tape wound core in conjunction with a resonant charging circuit to develop the waveforms which are needed to drive digital magnetic logic devices employing multiaperture ferrite cores in a resistance flux transfer scheme. (auth)

27878 (SC-DC-65-1400) PROPAGATION OF ULTRASOUND IN PLASTIC CRYSTALS (thesis). Carl E. Schele (New Mexico Univ., Albuquerque). 1965. Contract AT(29-1)-789. 97p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Ultrasonic velocity measurements were carried out using the transit-time method in the cubic solids cyclohexanol, cyclohexane, and camphene. The measurements were made above and below the transformation points, and elastic constants were calculated therefrom and used to study the binding in the solids. A nonlinear ultrasonic velocity vs temperature relation was noted for camphene. (D.L.C.)

27879 (SC-RR-65-160) PROPERTIES OF MOLECULAR SIEVE-TYPE DESICCANTS. George Voida (Sandia Corp., Albuquerque, N. Mex.). May 1965. Contract AT(29-1)-789. 40p. Dep.; $2.00(cy), 1(mn) CFSTI.

A study was made of the water-vapor adsorption properties of molecular sieve desiccants when exposed at several different test humidities. The thermal stability and also the decay characteristics of the desiccants after numerous reactivation cycles are presented. Glass cloth bags used in the packaging of regenerable desiccant units illustrate specific advantages in analytical investigations and in end-applications. The effectiveness of molecular sieve desiccants in the drying of rigid polyurethane foams is described. Preliminary studies of desiccant drying of internal atmospheres indicate the need for more extensive experimental work. The water-vapor transmissibility of various commercial plastic films was also determined. (auth)

27880 (SC-TM-64-1774) IMPROVED ADVANCE AND PRIME PULSE GENERATOR FOR DRIVING MAGNETIC LOGIC DEVICES. E. J. Bernard (Sandia Corp., Albuquerque, N. Mex.). Jan. 1965. Contract AT(29-1)-789. 27p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A pulse generator for generating prime and advance pulses for magnetic logic devices is described. The circuit is designed to operate from low voltage power supplies and has the capability of driving a large number of bits with low distortion of the advance waveform. Tests conducted on a typical unit have shown that it will operate over a temperature range of −100°F to 180°F. The design of a typical unit is presented. (auth)

27881 (SC-TM-65-115) MOS MONOSTABLE MULTIVIBRATOR ELECTROMETER. L. M. Bossart (Sandia Corp., Albuquerque, N. Mex.). Apr. 1965. Contract AT(29-1)-789. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An electrometer circuit is described which will measure currents from 10^{-11} to 10^{-6} amperes. The circuit output is a pulse the width of which varies inversely with the input current. Although laboratory equipment is available which will make measurements in this current range, the circuit described has a minimum number of parts and yet is capable of making all necessary steady-state d-c measurements in a rocket payload. (auth)

27882 (TID-21839) THE BIOSYNTHESIS OF TERTHIENYL IN THE COMMON MARIGOLD. Terry Bill Waggoner (Michigan State Univ., Ann Arbor). [196?]. Contract AT(11-1)-1034. 102p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

The biosynthetic pathway of the naturally occurring polythiophene, 2,2′; 5′,2″-terthienyl was studied. Marigold plants growing in nutrient solution were fed suspected precursors containing sulfur-35 or carbon-14. The materials used were sodium sulfate-S-35, sodium hydrogen sulfide-S-35, L-methionine-S-35, DL-methionine-1-C-14, DL-methionine-2-C-14, succinic acid-2,3-C-14, DL-glutamic acid-2-C-14, and sodium acetate-1-C-14. Terthienyl was isolated from the roots at specific times from the initial feeding, and its radioactivity was determined. From the experimental evidence obtained, a biosynthetic scheme involving homocysteine as a possible precursor is presented. (auth)

27883 (UCRL-7463) CEL: A TIME-DEPENDENT, TWO-SPACE-DIMENSIONAL, COUPLED EULERIAN-LAGRANGE CODE. W. F. Noh (Lawrence Radiation Lab., Univ. of California, Livermore). Aug. 1963. Contract W-7405-eng-48. 72p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The CEL code is a time-dependent, two-space-dimensional (compressible, inviscid, non-heat-conducting) hydrodynamics code that enables an Eulerian approximation of some regions of a fluid to be coupled with a Lagrange approximation for each of the adjacent regions of the fluid. The central feature of CEL (Coupled Euler-Lagrange) is a method for calculating the solution of a time-dependent, two-space-dimensional Eulerian hydrodynamics problem for a region with an arbitrary polygonal approximating mesh having a general moving (time-dependent) fluid boundary. (T.F.H.)

27884 (UCRL-7569-T) WRITE-UP OF SUBROUTINE ROMBRG, A GENERAL-PURPOSE ROUTINE FOR NUMERICAL INTEGRATION. Fred N. Fritsch (Lawrence Radiation Lab., Univ. of California, Livermore). Oct. 1963. Contract W-7405-eng-48. 16p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A rapidly convergent iterative program is presented for numerically calculating the value of a definite integral, using the ROMBRG method. (T.F.H.)

27885 (UCRL-7623) ON THE NON-EXISTENCE OF FIBONACCI SQUARES. Robert E. Shafer (Lawrence Radiation Lab., Univ. of California, Livermore). Dec. 1963. Contract W-7405-eng-48. 6p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

The Fibonacci sequence, defined as $F_0 = 0$, $F_1 = 1$, $F_2 = 1$, and $F_n = F_{n-2} + F_{n-1}$, has for known squares $F_1 = F_2 = 1$

and $F_{12} = 144$. It is proved that no other Fibonacci squares exist, using the exclusion technique of Wunderlich and the induction method. (M.J.T.)

27886 (UCRL-7759-T) MIXING AND CHEMICAL REACTION IN TURBULENT FLOW REACTORS. R. Norris Keeler, E. E. Petersen, and John M. Prausnitz (California Univ., Berkeley and Lawrence Radiation Lab., Univ. of California, Livermore). [1964]. Contract [W-7405-eng-48]. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Mixing and a rapid, second-order irreversible chemical reaction were studied in a turbulent chemical flow reactor, using a point conductivity probe to detect changes in concentration. Using the mathematical theory of Toor, it is shown experimentally that data on the mixing of a passive scalar additive in a non-reactive system may be used accurately to predict the yield of a rapid, irreversible second-order reaction when the hydrodynamics and initial conditions on mixing for the reactive system are identical to those of the non-reactive system. Increasing the bulk average concentration of one reactant is shown to have a strong effect on the overall reaction yield. (auth)

27887 (UCRL-7765-T(Rev.1)) EFFECTIVE FLUORESCENT LIFE TIMES IN RUBY LASER RODS. J. A. Fleck, Jr. (Lawrence Radiation Lab., Univ. of California, Livermore). Apr. 15, 1964. Contract W-7405-eng-48. 21p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

In the presence of a population inversion, fluorescent life times are reduced as a result of stimulated emission. Effective fluorescent life times were calculated using a Monte Carlo method for ruby rods with Brewster angle ends and roughened sides. The calculations take into account the dependence of gain and reflectivity on polarization and the dependence of gain on frequency. Results show that effective fluorescent life times are quite insensitive to rod length but strongly dependent on rod diameter. They also indicate the possibility of oscillation in a random mode for rods of sufficiently large diameter. (auth)

27888 (UCRL-11001(Rev.)) KINETICS OF THE ANATASE–RUTILE TRANSFORMATION. Robert D. Shannon and Joseph A Pask (Lawrence Radiation Lab., Univ. of California, Berkeley). Apr. 30, 1964. Contract W-7405-eng-48. 54p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Transformation of three commercial anatase powders resulted in sigmoid transformation curves, which were interpreted in terms of a nucleation-growth process. Analysis of these curves by means of several rate laws led to activation energies for nucleation of 110, 135, and 150 kcal/mole, for growth of 100, 115, and 190 kcal/mole for the three materials. A literature review made of the effects of impurities on the transformation suggested that the rate of transformation is governed by the defect structure of the TiO_2, i.e., by the concentration of oxygen vacancies or titanium interstitials. In this study both CuO additions and a hydrogen atmosphere were found to accelerate the transformation. It is proposed that CuO accelerates the transformation by formation of a substitutional solid solution and a consequent increase in oxygen-vacancy concentration, and hydrogen accelerates the transformation either by the introduction of oxygen vacancies or by reduction to a second Ti_nO_{2n-1} Magnéli phase. A vacuum of 3×10^{-4} mm Hg was found to retard the rate of transformation. This was attributed to the introduction of titanium interstitials. (auth)

27889 (UCRL-13132) FINAL REPORT FOR TELEMETRY SYSTEM STUDY. (Montana State Coll., Bozeman. Electronics Research Lab.). Sept. 1964. For Univ. of California Lawrence Radiation Lab., Livermore. Contract W-7405-eng-48, ERL Contract 8-0009-751. 30p. Dep.(mn); $2.00(cy), 1(mn)

A system feasibility study was conducted on a wide-band, multi-channel telemetry system to replace buried cables in relaying transducer signals from remote locations. It is concluded that: (1) the formation of a composite signal of modulated subcarriers and the use of this signal to modulate the microwave carrier is the most feasible system approach; (2) the SSB method of modulating the subcarriers should be used; and (3) frequency modulation of the microwave generator should be used. (D.L.C.)

27890 (UCRL-16021) OXYGEN INITIATED PYROLYSIS OF ETHYLBENZENE. Edwin D. Hausmann and C. Judson King (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 29, 1965. Contract W-7405-eng-48. 57p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The effect of small quantities of oxygen (0 to 10%) on the thermal decomposition of ethylbenzene in the temperature range of 570-650°C was investigated utilizing a flow reactor with residence times of from 0.06 to 0.18 seconds and ethylbenzene concentrations of less than 10%. Twenty-one runs were made with oxygen excluded, and the data fitted, using a multiple regression analysis, to the following form of the law of mass action: rate of conversion to styrene = $4.04 \times 10^{12} \exp(-68{,}600/RT)(EB)^{0.41}$ g mole/cm^3 sec. The liquid product yield pattern of 74 mole % styrene, 23% benzene, and 3% toluene was found to be independent of temperature and reactant concentration. A mechanism is postulated which is in accord with the reaction order, apparent activation energy, and yield pattern. Small quantities of oxygen increase the rate of thermal decomposition but this effect tapers off as the oxygen concentration is increased. With an oxygen concentration of 2.5%, the same level of conversion is achieved at a temperature 10°C lower than that required when oxygen is excluded. The styrene yield selectivity increases from 74 mole % without oxygen to 81 mole % with 10% oxygen. When the data are fitted to a law of mass action expression, oxygen is found to lower the apparent activation energy to 60,000 cal/gm-mole and to lower the order with respect to ethylbenzene slightly. Possible initiation and termination reaction steps involving oxygen are suggested to explain the results, but it is not possible to test any definite reaction mechanism for the oxygen-initiated pyrolysis of ethylbenzene reliably. (auth)

27891 THE DEVELOPMENT OF NUCLEAR ENERGY AND NUCLEAR INDUSTRY IN THE USA. R. Hossner. Atomwirtschaft, 10: 178-84(Apr. 1965). (In German)

Observations on the American nuclear market are presented. The industrial evolution in this field and what industrial capacity is impinging from without on the European market are considered. The program of the USAEC in 1964 was orientated toward a further strengthening of American industry. More tasks, which were previously carried out in AEC installations, were taken over by private undertakings, partly as operators of these installations and partly by taking over the production in their own plants. The confidence of industry in the fulfillment of the long-term development forecasts was marked by its own increasing research and development expenditure in this field. The non-appearance in 1964 of new contracts for atomic power stations did not conflict with the estimate by the AEC of 5,000 Mw(e) of installed nuclear capacity by 1970. The long-term further development to 1980, which two years previously was estimated at 40,000 Mw(e), was, after some investigations, placed at about 70,000 Mw(e). The delivery of nuclear-technological products showed a distinct rise in all fields in the year under review. (auth)

27892 TREND OF ATOMIC INDUSTRY, AS SEEN FROM THE STANDPOINT OF ECONOMY. Genshiryoku Chosa Jiho, No. 9, 46-57(Mar. 1965). (In Japanese)

The trends of the nation's atomic industry were investigated every year since 1960. The trend for the period from 1956 to 1963 is described on the basis of the expenditures in the field. The atomic industry is described on the basis of the following four groups: atomic materials and equipment producers, where expenditures increased remarkably until fiscal 1961 but showed little increase thereafter; atomic power generation, with a small but steady increase each year; uses of radioisotopes and radiations where increases and decreases alternated at one and one and a half year intervals; and

trade firms, with a steady trend of exports and imports. (NSA of Japan)

27893 TEN YEARS' PROGRESS IN THE DEVELOPMENT OF ATOMIC ENERGY IN JAPAN (SPECIAL EDITION). Hiroshi Murata (Japan Atomic Energy Bureau) and Sakuji Komagata. Genshiryoku Kogyo, 11: No. 4, 32-104(Apr. 1965). (In Japanese)

The development of atomic energy in Japan is discussed. Establishment of the Japan Atomic Energy Research Institute, Japan Atomic Fuel Corporation, industrial atomic-energy development groups, etc., is reviewed. The number of reactors in operation is six. Research and development are also in progress in the fields of radiation applications, medicine, engineering and technology, agriculture, and other sciences. In the field of industrial power generation by atomic energy, the Tokai power station is expected to start operation this year. Construction of Japan's first nuclear-powered ship is to be started this autumn. Topics discussed include: atomic energy development in Japan, as seen from outside the country; atomic power generation; research and test reactors; metal materials for reactor use; nuclear fuels; uses of radioisotopes; radiation chemistry; radiation instruments; nuclear-powered ships; plasma nuclear fusion; atomic energy research in universities and colleges; progress in the atomic industry; progress of the Sumitomo Atomic Energy Group; progress of the NAIG; and progress of the Mitsubishi Atomic Energy Group. (NSA of Japan)

27894 RECENT ADVANCES IN AEROSOL RESEARCH. A BIBLIOGRAPHICAL REVIEW. C. N. Davies. A Pergamon Press Book. New York, The Macmillan Company, 1964. 87p.

Research progress on aerosols is reviewed. Emphasis is placed on contributions to pure science with little mention of applications. Topics covered include: acoustic, ultrasonic, and shock-wave effects; adhesion of particles; chemical reactions; coagulation and diffusion; combustion; concentration, particle size, and shape; electric properties; evaporation and condensation; filtration; generators; laminar flow and impingement; nucleation and growth; optics of aerosols; photophoresis; radioactivity; sampling instruments; sedimentation and fluid resistance; thermophoresis and diffusiophoresis; and turbulent flow and deposition of aerosols. (M.C.G.)

27895 ATOMENERGIE IN DEUTSCHLAND. EIN BERICHT UBER STAND UND ENTWICKLUNG DER KERNFORSCHUNG UND KERNTECHNIK IN DER BUNDESREPUBLIK DEUTSCHLAND. (Atomic Energy in Germany. A Report on the Position and Development of Nuclear Research and Nuclear Technology in the German Federal Republic). Robert Gerwin. Dusseldorf and Vienna, Econ-Verlag GmbH, 1964. 174p.

A review of the development of nuclear energy in the German Federal Republic is given with emphasis on federal and industrial contributions. Possible future developments are indicated. The German law on control of nuclear energy, the atomic program for 1963–1967, a list of reactors and accelerators, and the organization of the German Atomic Commission are given. (J.S.R.)

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

ä	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

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SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is identifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ξ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly. Cross references appear in the index cumulations. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

Specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Whenever it appears that such information would be useful, descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract. Such phrases are written so that the idea considered most important is presented first. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium—allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

For entries concerned with physics, if the modifier does not indicate whether the reference is experimental or theoretical, a symbol E or T or E/T is given.

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52	19-27779	Dep.(mn)
HW–		
56210	19-26461	Dep.(mn); $1.00(cy), 1(mn) CFSTI
69168(Suppl.)	19-27820	Dep.; $4.00(cy), 3(mn) CFSTI
78968	19-27766	Dep.(mn); $2.00(cy), 1(mn) CFSTI
81933	19-26575	Dep.(mn); $1.00(cy), 1(mn) CFSTI
82705	19-26576	Dep.(mn); $1.00(cy), 1(mn) CFSTI
82797	19-27809	Dep.; $2.00(cy), 1(mn) CFSTI
83609	19-27832	Dep.(mn); $2.00(cy), 1(mn) CFSTI
83610	19-27833	Dep.; $2.00(cy), 1(mn) CFSTI
83854	19-27845	Dep.(mn); $2.00(cy), 1(mn) CFSTI
84509	19-26462	Dep.(mn); $1.00(cy), 1(mn) CFSTI
84617	19-27846	Dep.; $2.00(cy), 1(mn) CFSTI
HW-SA–		
3519	19-27418	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3540	19-27847	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3700	19-27756	Nucl. Sci. Eng., 22: 206-14(1965)
IA–	**(Non-AEC)**	
115	19-27589	See AD-606829
984	19-26917	Dep.(mn)
IAE–	**(Russian)**	
674	19-27601	Dep.(mn)
676	19-27622	For translation see CLM-Trans-6
696	19-26631	Dep.(mn)
697	19-26655	Dep.(mn)
699	19-26656	Dep.(mn)
IC–	**(Non-AEC)**	
65/36	19-27138	Dep.(mn)
IDO–		
11300(Add.)	19-26720	Dep.; $1.00(cy), 1(mn) CFSTI
12031	19-26657	Dep.(mn); $1.00(cy), 1(mn) CFSTI
12040	19-27834	Dep.(mn); $2.00(cy), 2(mn) CFSTI
14630	19-26463	Dep.(mn); $2.00(cy), 1(mn) CFSTI
17064	19-27821	Dep.; $1.00(cy), 1(mn) CFSTI
IITRI–	**(Misc.)**	
A6034-2(App.II)	19-27545	Phys. Rev., 138: B1024-7(1965)
INP–	**(Polish)**	
317	19-26632	CFSTI
360	19-26283	CFSTI
INR–	**(Polish)**	
548/XVII	19-26377	Dep.
555/XIV	19-27063	Dep.
557/XIV	19-26785	Dep.
568/XIX	19-26577	Dep.
573/IXA	19-27392	Dep.
590/VIII	19-26229	CFSTI
593/IA/PH	19-26633	Dep.
601/VI/PH	19-27419	Dep.(mn)
INSJ–	**(Japanese)**	
81	19-27139	Dep.(mn)
82	19-27111	Dep.(mn)
IPP–	**(Non-AEC)**	
3/27	19-27602	Dep.(mn)
4/13	19-27366	Dep.(mn)
IRD–	**(British)**	
64-36(Pt.3)	19-27131	$6.00(CFSTI)
IS–		
599	19-26773	J. Nucl. Mater., 16: 42-8(1965)
1086	19-27420	Dep.; $4.00(cy), 3(mn) CFSTI
1128	19-26749	Dep.; $2.00(cy), 1(mn) CFSTI
1140	19-27140	Dep.; $1.00(cy), 1(mn) CFSTI
ISS–	**(Italian)**	
64/29	19-27367	Dep.(mn)
64/41	19-27141	Dep.(mn)
64/46	19-27142	Dep.(mn)
JAERI–	**(Japanese)**	
1069	19-26659	Dep.(mn)
JINR–	**(Russian)**	
E-1855	19-26660	Dep.(mn)
E-2085	19-27143	Dep.(mn)
P-1960	19-27287	Dep.(mn)
P-1961	19-27288	Dep.(mn)
P-1964	19-27144	Dep.(mn)
P-1969	19-27421	Dep.(mn)
P-1970	19-27422	Dep.(mn)
P-1971	19-27145	Dep.(mn)
P-1972	19-27423	Dep.(mn)
P-1974	19-27146	Dep.(mn)
P-1978	19-27424	Dep.(mn)
P-1979	19-27147	Dep.(mn)
P-1981	19-26970	Dep.(mn)
P-1984	19-26971	Dep.(mn)
P-1985	19-26972	Dep.(mn)
P-1990	19-26918	Dep.(mn)
P-1998	19-27148	Dep.(mn)
P-1999	19-27149	Dep.(mn)
P-2003	19-27425	Dep.(mn)
P-2021	19-27150	Dep.(mn)
P-2022	19-27151	Dep.(mn)
P-2026	19-27426	Dep.(mn)
P-2027	19-27152	Dep.(mn)
P-2030	19-27427	Dep.(mn)
P-2032	19-27428	Dep.(mn)
P-2034	19-27153	Dep.(mn)
P-2037	19-27429	Dep.(mn)
P-2038	19-27430	Dep.(mn)
P-2040	19-27431	Dep.(mn)
P-2043	19-27603	Dep.(mn)
P-2052	19-27432	Dep.(mn)
P-2057	19-26661	Dep.(mn)
P-2058	19-27154	Dep.(mn)
P-2060	19-27433	Dep.(mn)
P-2061	19-27155	Dep.(mn)
P-2063	19-27434	Dep.(mn)
P-2066	19-27156	Dep.(mn)
P-2071	19-27157	Dep.(mn)
P-2076	19-27750	Dep.(mn)
P-2116	19-27435	Dep.(mn)
P-2141	19-27158	Dep.(mn)
JPL-TR–	**(Non-AEC)**	
32-695	19-27604	$1.00(CFSTI)

Report No.	Abstract No.	Availability
32-707	19-27605	$1.00(CFSTI)
JPRS-	**(Non-AEC)**	
29075	19-26925	$6.00(CFSTI)
JüL-	**(German)**	
203-PP	19-27606	Dep.(mn)
K-DP-		
515	19-27848	Dep.(mn); $1.00(cy), 1(mn) CFSTI
K-L-		
6008	19-26301	Inorg. Chem., 4: 751-4(1965)
6009	19-26302	Inorg. Chem., 4: 755-7(1965)
KAPL-		
3092	19-26817	Dep.(mn); $1.00(cy), 1(mn) CFSTI
KAPL-M-		
6143	19-27393	Dep.(mn); $2.00(cy), 2(mn) CFSTI
6198	19-27751	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6420	19-27394	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6446	19-26518	Dep.(mn); $2.00(cy), 1(mn) CFSTI
KFK-	**(German)**	
257	19-26662	Dep.(mn)
258	19-26453	Dep.(mn)
267	19-26256	Intern. J. Radiation Biol., 8: 35-43(1964)
279	19-26284	Dep.(mn)
KN-	**(Non-AEC)**	
685-63-1	19-27822	
KR-	**(Norwegian)**	
93	19-27710	Dep.(mn)
LA-		
3126	19-27159	Dep.; $2.00(cy), 1(mn) CFSTI
3129	19-27319	Dep.; $3.00(cy), 1(mn) CFSTI
3144	19-26499	Dep.; $5.00(cy), 3(mn) CFSTI
3147-MS	19-27064	Dep.; $3.00(cy), 2(mn) CFSTI
3247	19-26230	Dep.; $1.00(cy), 1(mn) CFSTI
3260	19-27607	Dep.; $1.00(CFSTI)
3279	19-27780	Dep.; $4.00(cy), 2(mn) CFSTI
3285	19-26883	Dep.; $3.00(cy), 2(mn) CFSTI
LA-DC-		
6140	19-26831	Inorg. Chem., 4: 691-7(1965)
6372	19-27849	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6738	19-26339	J. Phys. Chem., 69: 1641-4(1965)
6765	19-26973	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6780	19-26974	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6791	19-26841	J. Nucl. Mater., 16: 87(1965)
6794	19-25822	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6821	19-26786	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6827	19-26583	Aerospace Med., 36: 55(1965)
6856	19-26634	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6892	19-27503	Nature, 206: 284-6(1965)
6927	19-26317	J. Chem. Phys., 42: 3822-5(1965)
6940	19-27081	J. Chem. Phys., 42: 4116-23(1965)
LADC-		
6477	19-27850	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6485	19-26285	Dep.(mn); $2.00(cy), 1(mn) CFSTI
LAMS-		
2983(Suppl.)	19-26491	Dep.; $1.00(cy), 1(mn) CFSTI
LNF-	**(Italian)**	
64/48	19-27368	Dep.(mn)
64/49	19-27369	Dep.(mn)
64/67(Rev.)	19-27160	Dep.(mn)
65/4	19-26975	Dep.(mn)
MATT-		
202	19-26942	Phys. Fluids, 8: 920-34(1965)
305	19-27608	Dep.; $2.00(cy), 1(mn) CFSTI
306	19-27651	Phys. Fluids, 8: 912-19(1965)
MIT-	**(Misc.)**	
2098-88	19-27128	Space Sci. Rev., 4: 123-46(1965)
2098-87	19-27193	J. Math. Phys. (N. Y.), 6: 795-816(1965)
2098-102	19-27527	Nucl. Phys., 69: 337-61(1965)
2098-126	19-27196	J. Math. Phys. (N. Y.), 6: 825-?(1965)
2249-2	19-26739	Dep.(mn); $1.00(cy), 1(mn) CFSTI
ML-TDR-	**(Non-AEC)**	
64-148	19-26801	See AD-607530
64-280(Suppl.)	19-26803	See AD-611165
MPI-PA-	**(Misc.)**	
12/64	19-27609	Dep.(mn)
13/64	19-27610	Dep.(mn)
14/64	19-27611	Dep.(mn)
18/64	19-27612	Dep.(mn)
MSAR-	**(Misc.)**	
65-62	19-26768	Dep.(mn); $1.00(cy), 1(mn) CFSTI
MURA-	**(Misc.)**	
708	19-26663	Dep.; $1.00(CFSTI)
712	19-26976	Dep.; $2.00(cy), 1(mn) CFSTI
714	19-26977	Dep.; $9.42(cy), 12(mn) CFSTI
N-	**(Misc.)**	
64-18080	19-26919	$0.75(CFSTI)
64-19590	19-26664	See NASA-TM-X-51623
64-20115	19-27586	See AD-428606
64-20193	19-27613	$0.75(CFSTI)
65-16203	19-27417	See GA-5944
65-16552	19-27604	See JPL-TR-32-695
65-19701	19-27386	See GA-5750
65-20110	19-27605	See JPL-TR-32-707
65-21626	19-26769	$3.00(CFSTI)
NAA-SR-		
8617(Vol.III)	19-26818	Dep.; $5.00(cy), 3(mn) CFSTI
10501	19-27735	Preceded by Report No. NAA-SR-1085
10850	19-27735	Dep.; $6.00(cy), 5(mn) CFSTI
NASA-CR-	**(Misc.)**	
213	19-26286	
228	19-26635	$4.00(CFSTI)
54230	19-27386	See GA-5750
54263	19-27417	See GA-5944
54344	19-26769	See N65-21626
57527	19-27605	See JPL-TR-32-707
NASA-SP-	**(Misc.)**	
54	19-27353	$2.25(GPO)
NASA-TM-	**(Non-AEC)**	
X-51623	19-26664	CFSTI
NASA-TN-	**(Misc.)**	
D-2235	19-26919	See N64-18080
D-2324	19-27613	See N64-20193
D-2718	19-26522	$2.00(CFSTI)
D-2791	19-27614	$1.00(CFSTI)
D-2804	19-26523	$2.00(CFSTI)
NASA-TT-	**(Non-AEC)**	
F-315	19-27321	$8.85(CFSTI)
NBS-TN-	**(Misc.)**	
256	19-27615	$0.25(GPO)
NEVIS-	**(Misc.)**	
131	19-27161	Dep.(mn); $3.00(cy), 2(mn) CFSTI
NIJS-R-	**(Yugoslavian)**	
427	19-26464	Dep.(mn)
432	19-26287	Dep.(mn)
439	19-26378	Dep.(mn)
442	19-26884	Dep.(mn)
NIRL-R-	**(British)**	
80	19-27020	Dep.(mn); $1.00(BIS); 5s. (HMSO)
82	19-27021	Dep.(mn); $0.50(BIS); 2s. 6d. (HMSO)
83	19-26885	Dep.(mn); $0.50(BIS), 2s. 6d. (HMSO)

Report No.	Abstract No.	Availability
NLCO–		
944	19-26231	Dep.; $1.00(cy), 1(mn) CFSTI
NMI–	**(Misc.)**	
4787	19-26819	Dep.(mn); $3.00(cy), 2(mn) CFSTI
7263	19-27781	Dep.(mn); $3.00(cy), 2(mn) CFSTI
NP–	**(AEC File No. for Non-AEC Reports)**	
14813	19-26379	Dep.(mn)
14819	19-27132	$1.00(cy), 1(mn) CFSTI as AD-610673
14823	19-26552	
14833	19-27436	
14849	19-27289	Dep.(mn)
14872	19-26288	Dep.(mn)
14875	19-26665	Dep.(mn); $2.00(cy), 1(mn) CFSTI
14903	19-25838	Dep.(mn)
14909	19-27162	Dep.(mn)
14912	19-27616	Dep.(mn)
14938	19-26920	
14992	19-26515	Dep.(mn)
14995	19-27370	
15039	19-26717	Dep.(mn)
15042	19-26289	Free(NBS, Washington, D. C.)
NRC–	**(Canadian)**	
8349	19-27447	Can. J. Phys., 43: 770-81(1965)
8433	19-26310	J. Am. Chem. Soc., 87: 1827-32(1965)
NRL–	**(Misc.)**	
6205	19-26492	$2.75(CFSTI)
6256	19-27437	$6.00(CFSTI)
NSL–	**(Non-AEC)**	
63-148-7	19-27617	
NUMEC–		
3428-9	19-26820	Dep.(mn); $1.00(cy), 1(mn) CFSTI
NYO–		
1018-3	19-27851	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1480-16	19-26750	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1726-14	19-26666	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1918-100	19-25839	Dep.(mn); $2.00(cy), 1(mn) CFSTI
2456-1	19-25905	Dep.(mn); $1.00(cy), 1(mn) CFSTI
2780-1	19-26290	Dep.(mn); $4.00(cy), 3(mn) CFSTI
3120-1	19-25963	J. Albert Einstein Med. Center, 2: 10-12 (1963)
3273-6	19-25831	Dep.(mn); $3.00(cy), 3(mn) CFSTI
3304-4	19-26500	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3329-2	19-26380	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3364-1	19-26533	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3364-4	19-26534	Dep.(mn); $2.00(cy), 1(mn) CFSTI
7240	19-26291	Dep.(mn); $3.00(cy), 2(mn) CFSTI
10361	19-26568	Dep.(mn); $3.00(cy), 1(mn) CFSTI
10722	19-27852	Dep.(mn); $5.00(cy), 3(mn) CFSTI
OR–	**(Misc.)**	
6427	19-26814	See CONF-650203-6
ORINS–		
49	19-25823	Dep.; Free(ORINS Medical Div.)
ORNL–		
3775	19-27811	Dep.; $3.00(cy), 2(mn) CFSTI
3796	19-26921	Dep.; $2.00(cy), 1(mn) CFSTI
3802	19-26718	Dep.; $3.00(cy), 2(mn) CFSTI
ORNL-NSIC–		
8	19-26578	Dep.; Free(ORNL)
ORNL-P–	**(Misc.)**	
67	19-25824	Dep.(mn); $1.00(cy), 1(mn) CFSTI
81	19-25908	Dep.(mn); $1.00(cy), 1(mn) CFSTI
116	19-27065	Dep.(mn); $1.00(cy), 1(mn) CFSTI
303	19-27494	J. Inorg. Nucl. Chem., 27: 903-6(1965)
331	19-26591	Health Phys., 11: 567-77(1965)
646	19-26772	J. Nucl. Mater., 16: 19-24(1965)
703	19-26600	Nucl. Appl., 1: 176-8(1965)
892	19-26851	Phys. Rev., 138: A1591-3(1965)
942	19-27543	Phys. Rev., 138: A1377-83(1965)
951	19-27732	Phys. Rev., 138: A1655-60(1965)
961	19-27513	Nucl. Phys., 69: 131-9(1965)
974	19-27549	Phys. Rev., 138: B1067-79(1965)
1134	19-27022	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1176	19-27567	Phys. Rev., 138: B1425-33(1965)
1185	19-27655	Phys. Fluids, 8: 984-90(1965)
1211	19-25909	Dep.(mn); $2.00(cy), 2(mn) CFSTI
1212	19-27853	Dep.(mn); $2.00(cy), 1(mn) CFSTI
ORNL-RSIC–		
3	19-27395	Dep.; Free(ORNL)
7	19-27702	Dep.; Free(ORNL)
ORNL-TM–		
962	19-27551	Phys. Rev., 138: B1083-8(1965)
970	19-27550	Phys. Rev., 138: B1080-3(1965)
977	19-27703	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1038	19-25910	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1069	19-26219	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1097	19-26465	Dep.(mn); $2.00(cy), 2(mn) CFSTI
1108	19-27835	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1113	19-27752	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1127	19-27782	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1133	19-27767	Dep.(mn); $8.12(cy), 8(mn) CFSTI
P–	**(Misc.)**	
1089(RAND)	19-27320	$1.00(CFSTI)
2496(RAND)	19-27112	$2.00(CFSTI)
PAN–	**(Polish)**	
532/I-A	19-27438	Dep.
551/VI	19-27439	Dep.
552/VI	19-27163	Dep.
556/IA	19-27704	Dep.
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
889,351	19-26799	
984,193	19-27759	
984,199	19-26512	
984,213	19-26761	
984,226	19-26737	
984,294	19-26762	
984,387	19-27806	
984,439	19-27760	
984,489	19-26873	
984,507	19-27746	
984,566	19-27747	
984,594	19-27761	
984,641	19-27748	
984,656	19-27807	
984,692	19-27808	
984,719	19-26513	
984,846	19-26874	
984,847	19-26875	
984,863	19-26517	
984,931	19-27770	
985,169	19-26800	
PATENTS	**(U. S.)**	**$0.25 each, U. S. Patent Office**
3,172,728	19-26763	
3,172,818	19-27762	
3,172,819	19-27763	
3,172,820	19-27764	
3,172,821	19-27771	
3,173,320	19-26497	
PB–	**(Non-AEC)**	
171809(Rev.) (Suppl.)	19-26803	See AD-611165
PG-Report–	**(British)**	
628	19-26233	Dep.
PNE–		
402	19-27854	Dep.(mn); $2.00(cy), 2(mn) CFSTI
408	19-27855	Dep.(mn); $1.00(cy), 1(mn) CFSTI
409	19-27856	Dep.(mn); $3.00(cy), 2(mn) CFSTI
410	19-27857	Dep.(mn); $1.00(cy), 1(mn) CFSTI

Report No.	Abstract No.	Availability
411	19-27858	Dep.(mn); $3.00(cy), 2(mn) CFSTI
412	19-27859	Dep.(mn); $2.00(cy), 2(mn) CFSTI
413	19-27860	Dep.(mn); $2.00(cy), 2(mn) CFSTI
414	19-27861	Dep.(mn); $1.00(cy), 1(mn) CFSTI
415	19-27862	Dep.(mn); $2.00(cy), 1(mn) CFSTI
416	19-27863	Dep.(mn); $2.00(cy), 1(mn) CFSTI
417	19-27864	Dep.(mn); $3.00(cy), 2(mn) CFSTI
418	19-27865	Dep.(mn); $2.00(cy), 1(mn) CFSTI
419	19-27866	Dep.(mn); $3.00(cy), 2(mn) CFSTI
430	19-27867	Dep.(mn); $2.00(cy), 1(mn) CFSTI
431	19-27868	Dep.(mn); $4.00(cy), 3(mn) CFSTI
432	19-27869	Dep.(mn); $4.00(cy), 3(mn) CFSTI
433	19-27870	Dep.(mn); $2.00(cy), 1(mn) CFSTI
434	19-27871	Dep.(mn); $4.00(cy), 2(mn) CFSTI
435	19-27872	Dep.(mn); $3.00(cy), 2(mn) CFSTI
436	19-27873	Dep.(mn); $3.00(cy), 1(mn) CFSTI
437	19-27874	Dep.(mn); $2.00(cy), 1(mn) CFSTI
438	19-27875	Dep.(mn); $3.00(cy), 2(mn) CFSTI
465	19-27876	Dep.(mn); $1.00(cy), 1(mn) CFSTI
609F	19-26486	Dep.; $3.00(cy), 2(mn) CFSTI
PPAD–		
2137-535	19-27544	Phys. Rev., 138: B1017-23(1965)
2137-542	19-27023	Dep.(mn); $1.00(cy), 1(mn) CFSTI
2137-546	19-27024	Dep.(mn); $1.00(cy), 1(mn) CFSTI
PR-P–	**(Canadian)**	
64	19-26922	Dep.; $1.50(AECL)
PWAC–	**(Misc.)**	
453	19-27753	Dep.; $3.00(cy), 1(mn) CFSTI
R–	**(Misc.)**	
64SD91	19-26524	$1.00(CFSTI)
156	19-26626	See AD-611007
489	19-27161	See NEVIS-131
RADC-TDR–	**(Misc.)**	
64-272	19-27618	$2.00(CFSTI)
RCN–	**(Dutch)**	
34	19-26668	Dep.(mn)
RFP–		
115	19-26466	Dep.(mn); $3.00(cy), 2(mn) CFSTI
446	19-26579	Dep.(mn); $2.00(cy), 1(mn) CFSTI
516A	19-26220	Dep.; $0.50(cy), 1(mn) CFSTI
RISO–	**(Danish)**	
95	19-26381	Dep.(mn)
97	19-26234	Dep.(mn)
RM–	**(Misc.)**	
2500(RAND)	19-25903	See AD-608877
RMI–	**(Misc.)**	
2	19-26787	Dep.(mn); $3.00(cy), 2(mn) CFSTI
RPI–	**(Misc.)**	
321-1	19-26382	Dep.(mn); $1.00(cy), 1(mn) CFSTI
RRA–	**(Misc.)**	
T43	19-26535	
T45	19-26536	
T47	19-27396	
RSIC–	**(Non-AEC)**	
228	19-26757	
RTD-TDR–	**(Non-AEC)**	
63-4143	19-27586	See AD-428606
SC-DC–		
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